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FROM

Agric. experiment station,
Vermont.

1 June, 1901.

A PORTION OF THE EXPERIMENT STATION HERD.

STATE OF VERMONT.

NINTH

ANNUAL REPORT

OF THE

VERMONT AGRICULTURAL

EXPERIMENT STATION

1895.

MONTPELIER, VT.:
ARGUS AND PATRIOT PRINTING HOUSE.
1896.

THE VERMONT

Agricultural Experiment Station

BURLINGTON, VT.

BOARD OF CONTROL.

Pres. M. H. BUCKHAM, *Ex-officio*, *Chairman*.
Hon. E. J. ORMSBEE, Brandon.
Hon. CROSBY MILLER, Pomfret.
Hon. CASSIUS PECK, Brookfield.
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J. L. HILLS	Director and Chemist.
G. H. PERKINS	Entomologist.
L. R. JONES	Botanist.
F. A. RICH	Veterinarian.
B. O. WHITE	Assistant Chemist.
*F. A. HOLBROOK	Assistant Chemist.
D. D. HOWE	Farm Superintendent.
J. C. ROBINSON	Dairyman.
MARY A. BENSON	Stenographer.
E. H. POWELL	Treasurer.

---

* Connected with the fertilizer control, March 1st to June 1st.

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The Station

ANNOUNCEMENT.

The Vermont State Agricultural Experiment Station was established in accordance with an Act of the General Assembly approved November 24, 1886, for the purpose of promoting agriculture by scientific investigation and experiment.

The Station was established in connection with the University of Vermont and State Agricultural College, and for the past eight years has received the funds appropriated by Congress under the provisions of the Act commonly known as the "Hatch Act," approved March 2, 1887. The State appropriation expired in 1890.

The Station is prepared to analyze and test fertilizers, cattle foods, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, and useful or injurious insects, and to give information on various subjects of agricultural science for the use and advantage of the citizens of Vermont.

All chemical analyses, seed investigations, etc., proper to an experiment station, that can be used for the public benefit, will be made without charge. The Station will undertake no work the results of which are not at its disposal to use or publish if deemed advisable for the public good. The results of each analysis or examination will be promptly communicated to the party sending the sample. Those that are of general interest will be published in the annual report or in bulletins, for free distribution upon request. The work of the year will be summed up in the annual report of the Station.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Vermont citizen who is concerned in agriculture, whether farmer, manufacturer or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications so far as it lies in its power. All communications relating to agriculture, horticulture, plant or animal diseases, insects, etc., will be fairly considered, and, so far as possible, promptly answered.

The Station offices and laboratories are in the Station building, corner of Main street and University place. The Station farm and buildings are on the Williston road, adjoining the University grounds on the east. Electric cars pass within a quarter of a mile of the Station building, at Colchester avenue and University place. Both the Station and the farm have telephone connection (Station, "Burlington, 155-4," farm, "Burlington, 155-2"), and may be spoken from most telephone offices in the State.

☞Instructions for taking samples of fertilizers, fodders, milk, water, etc., will be sent on application. Parties desiring to send samples should first write for these directions. Many of the samples received are useless, being incorrectly drawn. Parcels by express, to receive attention, should be prepaid.

☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the

Agricultural Experiment Station,
BURLINGTON, VT.

The Station has issued to date (August, 1896), including the present number, 9 annual reports and 53 bulletins. Many of these are out of print. The following numbers are in print, and will be sent on request without charge as long as the supply lasts:

1888, April.	No. 9,	Smut in Oats, Insecticides and Fertilizers	8 pages.
November.	No. 13,	Methods of Cutting and Planting Potatoes; Fertilizer Analyses	12 pages.
1889, October.	No. 17,	Test of Dairy Cows at Vermont State Fair	16 pages.
		Third Annual Report	172 pages.
1890, January.	No. 18,	Pig Feeding	20 pages.
May.	No. 20,	Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1890	16 pages.
September.	No. 21,	A New Milk Test; Testing Milk at Creameries and Cheese Factories; Notes for the Laboratory	32 pages.
October.	No. 22,	Test of Dairy Cows: Home vs. Fair Grounds	12 pages.
1891, March.	No. 23,	Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1891	16 pages.
May.	No. 24,	Potato Blight and Rot	16 pages.
June.	No. 25,	The Bounty on Maple Sugar	4 pages.
September.	No. 26,	Maple Sugar	24 pages.
		Fifth Annual Report	168 pages.
1892, January.	No. 27,	Tests of Dairy Apparatus	12 pages.
April.	No. 28,	Plant Diseases	24 pages.
May.	No. 29,	Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1892	12 pages.
June.	No. 30,	The Results of the Bounty on Maple Sugar	8 pages.
1893, May.	No. 35,	Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1893	16 pages.
December.	No. 40,	Spraying Potatoes	20 pages.
1894, May.	No. 41,	Analyses of Commercial Fertilizers	16 pages.
July.	No. 42,	Bovine Tuberculosis	54 pages.
November.	No. 43,	Household Pests	8 pages.
December.	No. 44,	Spraying Orchards and Potato Fields	28 pages.
1895, March.	No. 45,	Analyses of Commercial Fertilizers	8 pages.
April.	No. 46,	Analyses of Commercial Fertilizers	16 pages.
May.	No. 47,	Commercial Fertilizers	40 pages.
October.	No. 48,	Gluten Feeds and Meals	20 pages.
December.	No. 49,	Potato Blights and Fungicides	24 pages.
1896, March.	No. 50,	Analyses of Commercial Fertilizers	8 pages.
April.	No. 51,	Analyses of Commercial Fertilizers	12 pages.
May.	No. 52,	Analyses of Commercial Fertilizers	24 pages.
August.	No. 53,	The Pollination of Plums	20 pages.
		Ninth Annual Report	240 pages.

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FINANCIAL REPORT

For the Fiscal Year Ending June 30, 1895,

Vermont Agricultural Experiment Station

IN ACCOUNT WITH

The United States Appropriation, 1894-5.

DR.

To Receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1895, as per Act of Congress, approved March 2, 1887........................$15,000 00

CR.

		Abstract.		
By	Salaries	1	$4,031 66	
“	Labor	2	3,905 32	
“	Publications	3	1,218 96	
“	Postage, stationery and telegrams	4	205 75	
“	Freight and express	5	54 93	
“	Heat, light and water	6	853 11	
“	Chemical supplies	7	116 87	
“	Seeds, plants, and sundry supplies	8	836 60	
“	Fertilizers	9	381 05	
“	Feeding stuffs	10	1,239 48	
“	Library	11	18 53	
“	Tools, implements and machinery	12	116 50	
“	Furniture and fixtures	13	52 00	
“	Scientific apparatus	14	173 56	
“	Live stock	15	1,109 32	
“	Traveling expenses	16	76 65	
“	Contingent expenses	17	196 86	
“	Building and repairs	18	412 85	
	Total,		— ——	$15,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Vermont Agricultural Experiment Station for the fiscal year ending June 30, 1895; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file and have been by us examined and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

Signed,

MATTHEW H. BUCKHAM,
CASSIUS PECK, } *Auditors.*
GARDNER S. FASSETT,

SEAL.

ATTEST,

E. HENRY POWELL,
Custodian.

REPORT OF THE DIRECTOR.

The present report covers the work of the Station from January 1 to December 31, 1895, although a considerable part of the feeding tests and of the investigation of the various forms of potato blight, which were begun between these dates, was not finished at the close of the year. The financial report covers the year ending June 30, 1895.

PUBLICATIONS.

Five bulletins and the eighth annual report, aggregating three hundred and one pages of printed matter, have been issued during the year and distributed to our entire mailing list.

March.	No. 45—Analyses of Commercial Fertilizers, 8 pages.
April.	No. 46—Analyses of Commercial Fertilizers, 12 pages.
May.	No. 47—Commercial Fertilizers, 38 pages.
October.	No. 48—Gluten Feeds and Meals, 20 pages.
November.	Eighth Annual Report, 200 pages (out of print).
December.	No. 49—Potato Blights and Fungicides, 24 pages, 5 plates.

Abstracts of the bulletins are reprinted in this report.

CHANGES IN STATION STAFF AND EQUIPMENT.

No change in the working force of the Station took place during the year. Early in 1896, however, Prof. F. A. Waugh, late horticulturist of the Oklahoma Station, and formerly connected with the Kansas station, was elected horticulturist to fill a vacancy.

The Station greenhouse has been repaired, and to some extent remodeled, during the year. The former horse barn has been made a part of the cow stable, and a new horse barn made by remodeling the west barn wing, hitherto used for tools and storage.

WORK OF THE YEAR.

The lines of work during 1895 have been much the same as in previous years. A brief resume of the results of the experimental work of the year will be found on the following pages under appropriate headings.

COMMERCIAL FERTILIZERS.

The analysis and inspection of the commercial fertilizers sold in Vermont is delegated by State law to the Experiment Station.

Ninety-two brands of commercial fertilizers were analyzed in 1895, and all results published by May 20. The analyses of the brands representing, probably, from three-quarters to nine-tenths of the trade of the State were published by the middle of April.

Two-thirds of the total number of brands analyzed were found to be above their guarantees, a quarter of the total number were deficient in a single ingredient, while only seven in ninety-two were deficient in two ingredients. It is safe to say that 95 per cent. of the brands sold in Vermont in 1895 contained the commercial equivalent of their guarantees.

The average goods of 1894 and 1895 differed in composition but slightly, and the cost of plant food to the consumer was found to be as low as at any time previous. It is believed, however, that if former prices for mixed goods were fair, present prices are too high. Attention is called to the practice of "home mixing."

So far as is known, no attempt has been made to estimate the consumption of commercial fertilizers in Vermont since 1889, when a canvass made by the station showed the probable use of a little over 4,000 tons. A very complete canvass made this year, using the data obtained from the railroad stations at which the goods were unloaded, indicates that not far from 13,000 tons are used yearly in this State.

COMMERCIAL FEEDS.

A study of the feeding stuffs sold in Vermont was made during 1895–96, which was designed to cover, 1. Kinds of feed used. 2. Chemical composition of the various feeds. 3. Cost of the nutrients in the various feeds. 4. Fertilizing value of various feeds. 5. Economical purchase.

1. One hundred and forty-one samples, representing 34 different kinds of feed, all on sale in Vermont, were analyzed.

2. The comparison of the results of these analyses with "standard" indicates that in general the average goods were of good quality. There was considerable variation in the feeding values of goods of the same class. This was especially true of the "mixed feeds." A few samples of mixed feeds and corn and oats were found which were suspicious, there being every indication that they contained an undue proportion of oat hulls. One so-called bran was adulterated with some fibrous material resembling disintegrated straw.

3. It was hoped that the application of the "Method of Least Squares" to the analyses and selling prices of the various feeds would give reliable "valuations" for the chief nutrients. Reliable data could not be obtained either by this or by any other means.

4. The estimated fertilizing value of the various feeds differed widely, ranging from $21.25 per ton in cotton seed meal to $3.69 in buckwheat flour. At ruling prices for the various forms of plant food, cotton seed meal contained plant food worth 90 per cent. of its cost, while the plant food in corn meal was worth but 32 per cent. of the cost of the meal.

PIG FEEDING.

In a series of pig feeding experiments with fourteen pigs:

1. Corn meal was found to have a slightly greater feeding value than whole corn, not enough, however, to, as a rule, pay for the cost of grinding.

2. Buttermilk and skim milk were found to have nearly equal feeding values.
3. Feeding meal wet proved more profitable than dry feeding.
4. Low prices emphasized the wisdom of early sales. In the present tests the last two months or more feeding cost more than the pork brought.
5. The fertilizing value of the food eaten was equivalent to 52 per cent. of its cost.

PLANT DISEASES.

When the study of potato diseases was first undertaken at this station, the term "Potato Blight" was supposed to refer to a single specific disease. Investigations have shown that two quite distinct fungus "blights" commonly attack Vermont potatoes. In the report of 1892 the popular names "Late Blight" and "Early Blight" are applied to these diseases. Owing to the complications of this latter disease with various other disorders, a critical study of the various causes leading to the premature death of potato plants was undertaken in 1895. The result of these studies has been to clearly distinguish three well marked and serious disorders, which are being popularly called "Early Blight." These are:

1. The typical Early Blight, or "Leaf Spot" disease.
2. Arsenical Poisoning from Paris Green, etc.
3. "Tip-burn," from drought, etc.

A detailed description of these diseased conditions and means of prevention are given in Bulletin 49, published in December, 1895.

These various disorders may occur simultaneously on the same plant, and even on a single leaf. This fact has led to much uncertainty as to the exact relation of the "early blight" fungus (*Macrosporium Solani, E. & M.*) to the disease. Careful and repeated experiments were made during 1895 to determine this relation if possible. The results leave no chance for doubt, as successful inoculations of the fungus were made by placing spores upon the healthy, unmutilated leaves of young potato plants growing out of doors, and under entirely normal conditions.

The experience of last year clearly taught that much could be done to prevent the occurrence of late blight and rot if more care were exercised in the use of seed potatoes chosen only from such pieces as were entirely free from the disease the previous year.

There is no hope, however, that this will be practiced by all growers the same year. Bordeaux mixture, therefore, remains as the sovereign remedy for potato blights. By its use the yield of our crops were largely increased last year, as usual. It has been hoped by some that the dry Bordeaux powder could be substituted for the mixture, owing to its greater convenience. Comparative tests show it to be decidedly inferior, however. A series of trials of the mixture, as made in various ways, has shown that the best mixture (*i. e.* one so made as to lessen, so far as may be, the clogging of the nozzles, etc., and yet retain perfect fungicidal properties) can be had only by using cold solutions, and so combining that there shall be at no time any excess of copper sulphate. Made thus, the precipitate will settle very slowly.

As in past years the disinfection of seed potatoes in corrosive sublimate gave a crop much freer from scab than was otherwise obtained. This remedy is simple, cheap and efficient, and should come into general use.

The spraying experiment on apple and pear trees began last year were continued with gratifying results. It is a settled fact that by the use of Bordeaux mixture the scabbing of apples and pears can be entirely prevented, at comparatively slight expense.

A favorable opportunity presented itself this year for investigation of the so-called "onion rust," of which vague rumors have reached the station from time to time for a number of years. The cause of the disease proves to be a mildew, of a nature similar to the fungus causing the late blight of the potato. It seems probable, therefore, that fungicides properly applied prevent it. This will be undertaken another season.

Investigations are being continued on weeds, especially the hawk weed or paint brush, and upon grasses. Salt is proving very helpful in killing the hawk weed. A bulletin upon this weed will be issued during the coming year.

EXPERIMENTS IN BEE KEEPING.

The experiments of the current year resulted as follows:

1. No perceptible difference has been noted thus far in the relative values of different sized frames in wintering or building up in the spring.
2. Stimulative spring feeding proved injurious.
3. Bees will make use of scrap wax in comb construction during the honey flow.
4. The Langdon non-swarmer proved for the second time a failure.
5. The periodical removal of all drones and drone brood failed to prevent swarming.
6. No difference could be detected by experts in the quality of honey produced under otherwise similar conditions upon different comb foundations.

THE "METHOD OF LEAST SQUARES" AS A MEANS OF DETERMINING THE MONEY VALUES OF COMMERCIAL FEEDS.

A valuation system has been applied by several German and American stations to commercial eeding stuffs, the money values of the various nutrients being determined by means of the mathematical process known as the "Method of Least Squares." A careful investigation of the subject has resulted in casting grave doubts upon its usefulness for this purpose, an outcome which was entirely unexpected when we began the study.

VARIATIONS IN MILK.

The conclusions presented herewith are based on something over one hundred lactations of cows of many breeds, diversely fed and in three geographical localties, data published by the New York (Geneva) and Minnesota stations being used in addition to a large amount of our own.

SUMMARY.

I. MONTHLY VARIATIONS DURING THE PERIOD OF LACTATION.

Quality. The average spring cow rapidly betters the quality of her milk, beginning about five months after calving; the summer cow starts in as early as the third month, while the fall cow maintains fairly even quality throughout her lactation period, seldom improving it more than half of one per cent. in fat contents. The per cent. of solids not fat also is most uniform month by month in the milk of the fall cow. The percentage of solids not fat in the milk of spring cows seems to lessen somewhat in the summer time.

Quantity. The average fall cow "holds out" as a rule better than the average spring cow, and, in the records now under discussion, as a rule gave larger yields.

Butter. The gross yields of spring and fall cows in the Vermont herd were the same, but in the New York and Minnesota herds, the average fall cow outstripped the average spring cow.

The Vermont fall cow held up the evenness of butter production better than the spring cow. Little, if any, difference was seen in this respect in the other herds.

2. EXTREME VARIATIONS IN QUALITY DURING THE PERIOD OF LACTATION.

The greatest monthly variation * in the quality of the milk of 115 cows was 3.06% fat, the least 0.33% fat. The widest difference involved a change from 26.4 pounds of milk to 14 pounds of milk to a pound of butter. The average variation was 1.26% fat. The average monthly variation of spring cows was 1.62% fat; of fall cows, 1.08% fat; of summer cows, 1.25% fat. The monthly variation of American Holderness and Devon cows seemed to exceed, and of Shorthorns to be less than those of cows of other breeds. The number of individuals in these breeds, however, was small as compared with the other breeds. Two-thirds of the Vermont and Minnesota herds gave thinnest milk during the first two months, and two-thirds of the New York during the first four months.

Ninety per cent. of the Vermont and Minnesota cows gave their richest milk after the seventh month. Sixty per cent. of the New York cows gave their richest milk before the eighth month. The arbitrary limitation of the New York records to a ten months' lactation may partially explain this.

---

* I. e. The difference between the lowest and highest average qualities for a month each.

3 VARIATIONS IN QUALITY AND QUANTITY OF MILK FROM YEAR TO YEAR.

But six of forty-three cows change ten per cent. in quality in successive years. Such slight change as was made was for the better in two-thirds of the cases. Quantity changes are too dependent upon feeding, etc., to admit of deductions being drawn.

4. THE QUALITY OF THE MILK OF STRIPPERS.

The milk given during the last few weeks before going dry is richer in fat and solids not fat, and of a higher specific gravity than the average of the milking period, provided the cow has been in calf for two months or more. This is not so surely true if the cow goes dry when farrow or when but recently served, as shown in seven cases instanced in the body of this article, in three of which exceedingly thin milk, far below the average normally given by the cow, was given just before drying oft.

5. WHEN TO TEST A COW FOR QUALITY AND QUANTITY OF MILK.

A large number of comparisons show that the average quality of the milk of the entire year may be found with considerable accuracy by testing two composite samples, taken in either of two ways.

1. Spring cows.—First sample taken 6 weeks after calving, and second, from 6½ to 7½ months after calving.

Summer cows. – First sample taken 8 weeks, and second one, from 6 to 7 months after calving.

Fall cows.—First sample taken from 8 to 10 weeks, and second, from 5½ to 7 months after calving.

2. By analysing two composite samples taken two weeks apart, date of taking in case of spring and fall cows to be 6 months after calving, and in case of summer cows to be 3 to 5 months after calving.

Quite close approximations to truth may be obtained by weighing the milk during four days in the middle of each month and calculating the total yield by multiplication. In forty-three per cent. of the cases, calculation was within two per cent. of truth. Butter yields calculated in this manner and by using two Babcock tests came close enough to the truth for most purposes.

6. EFFECT OF ABORTION ON QUANTITY AND QUALITY OF MILK.

The effect of abortion was found to be:

(*a*) A shrinkage of over one-third in milk yield. (*b*) A gain of one-tenth in quality. (*c*) A shrinkage of nearly one-third in butter yield. (*d*) A more even quality of milk throughout the milking period.

RECORD OF THE STATION HERD FOR 1894-5.

The Station herd which was killed in 1894 because of tuberculosis, averaged in 1892, 355, and in 1893, 330 pounds of butter per cow per year. Seventeen cows of the present herd, which have been members thereof for two years at the present writing, averaged 374 and 315 pounds of butter during the two successive years, while 31 cows of the present herd made an average of 325 pounds for the year ending October 31, 1895. But 81 per cent. as much milk and 85 per cent. as much butter was made by the seventeen cows above referred to in the second year as was produced during the first year, several running farrow and some aborting.

The extremes of yearly product and cost of yearly production were:

Milk, 8437 to 3083 pounds; total solids, 1096 to 449 pounds; fat, 396 to 161 pounds; butter, 462 to 189 pounds; cost of feed, $56.23 to $43.19; of grain, $21.94 to $16.05; of 100 pounds of milk, $1.41 to $0.65; of a pound of fat, 27 cents to 14 cents; of a pound of butter, 23 cents to 12 cents. Value of butter product at actual selling price, $108.62 to $44.04.

TESTS OF DAIRY APPARATUS.

A power test was made of the DeLaval Alpha Belt Separator, which proved to be more economical of steam than any Separator of the same size heretofore tried at this station.

FAST AND SLOW MILKING.

But little effect was observed upon the quality or quantity of the milk given when eight cows were slowly milked as compared with the yields obtained by the same person milking quickly.

MISCELLANEOUS FODDER CROPS.

Several fodder crops were grown experimentally which were sampled and analyzed.

MILLETS. *Japanese*. Cock's foot and panicle. Rapid grower, large tonnage of green fodder and dry matter per acre, but of low quality. Well relished by stock.

HUNGARIAN. Not as large as the Japanese varieties but richer, so that as large a total protein yield was obtained per acre from the other millets; well relished by cattle.

COW PEA. This plant was a failure in experiments already reported from this station (First Report, pp. 73-78.) Further trial has shown it to be of doubtful value as a factor in Vermont agriculture.

SOJA BEANS. Green, black and white; grow from three to four and one-half feet high; may be fed green, ensilaged or hayed; well relished by cattle in either form; grown at the rate of from three to two-thirds ton of dry matter per acre.

Flat Pea. Perennial leguminous plant, making after one year dense matted growth; not well relished unless cut early, then fairly well liked. Cut at the rate of nearly 7 tons of green fodder and nearly two tons dry matter per acre.

Vetch and Oats. Not equal to oats and peas.

Oats and Peas. A well known and very successful combination.

Bokhara or Sweet Clover. Bee plant; not eaten by cows except in its early stages; recommended for green manuring.

Clovers. *Crimson.* Made best growth of any spring-sown clover. Well liked by cattle. Summer and fall sown plots entirely winter-killed.

FEEDING TESTS.

Thirty-one cows were used in feeding trials during the winter of 1895-96. These trials lasted for twenty weeks, and were divided into five four-week periods. The first ten days of each period were considered preparatory, and the last eighteen experimental. Full records of the quantity and quality of the food eaten and the milk given were kept throughout.

The results obtained may be briefly stated as follows:

1. *Corn Ensilage vs. Beets,* five cows—A pound of dry matter gave essentially the same returns when ensilage was fed as when it was replaced by a similar amount from beets. Since the dry matter of ensilage is less digestible than that of beets, it follows that a pound of digestible dry matter from corn ensilage yielded better returns than a similar amount from the beets. It has been amply proved elsewhere that beets cost more and yield less per acre than corn, and the results reported herewith confirm previous tests in showing that, per pound of dry matter, they produce no more and no better milk than corn ensilage.

2. *Corn Ensilage vs. Carrots,* three cows.—The dry matter of ensilage and carrots was found to have essentially equal feeding values. Since the dry matter of carrots is nearly all digestible, it follows that the digestible dry matter of ensilage yielded better returns than that from carrots.

3. *Beets vs. Carrots,* two cows.—A pound of total and of digestible dry matter in the carrot ration produced two-fifths greater yield than a similar amount in beets.

4. *Corn Oil Cake vs. Corn Meal and Bran,* six cows.—A pound of dry matter in corn oil cake produced a twelfth more yield than a similar amount in corn meal and bran.

5. *Atlas Gluten Meal vs. Corn Meal and Bran,* six cows.—A pound of dry matter in Atlas gluten meal produced an eighth more milk and a sixth more butter than a similar amount in corn meal and bran.

6. *Cotton Seed Bran vs. Corn Meal and Bran,* four cows.—A pound of dry matter in cotton seed bran produced less milk and butter than a similar

amount in corn meal and bran, but on the basis of digestible dry matter was probably somewhat superior.

7. *Atlas gluten meal* alone changed the quality of the milk. When this feed was used, a slightly richer milk and somewhat narrower ratio of fat to solids not fat resulted. The change was too slight to lay stress upon.

8. *Experimental error in feeding cows*, five cows, the ration remaining unchanged in character.—A pound of total dry matter produced no more milk and butter at one time than at another, lactation stages being equalized. It is thought, however, that when but few animals are used in feeding trials, changes in product of at least four or five per cent. should occur before the results can be safely declared to be due to changes in feeding.

NUTRIOTONE.

Touching the article "Nutriotone," this Station makes a further and explanatory report.

"Nutriotone" was analyzed at this Station at the request of a party seeking information for his own use in conformity with the law requiring the station "to analyze feeding stuffs" for residents of this state, and it was analyzed and commented on as a feeding stuff only. We were not then aware that the principal claim made for it was as to its value as a tonic.

No attempt was made to determine whether the article possesses medicinal virtue as a tonic, or remedy for stock out of condition. Indeed, no analysis could disclose its value in that respect, which could be determined only by experiment. The only question which the station claims to have settled scientifically is the value of "Nutriotone" as a food, not as a tonic.

ABSTRACTS OF BULLETINS.

Bulletins Nos. 45-46-47—Commercial Fertilizers.—(1895.)

By J. L. Hills and B. O. White.

SUMMARY.*

The trade values of fertilizing ingredients in mixed goods in 1895 are 15, 18½ and 16½ cents per pound for nitrogen in nitrates, ammonia salts and in organic forms respectively; 6, 5¼ and 2 cents per pound for soluble and reverted, and insoluble phosphoric acids; 5½ and 4½ cents per pound for sulphate and muriate of potash.

These trade values do not represent the proper selling prices of mixed goods at the point of consumption, but are the retail cash prices of the various fertilizing ingredients in the large markets, unmixed but ready for use. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance.

The Station has analyzed samples of ninety-two distinct brands of fertilizers, all taken this spring from dealers' stocks and all this year's goods. This is thirty-nine more than were analyzed in 1894 and fifty-six more than in any year previous to that time.

Of the ninety-two brands analyzed, sixty, or two-thirds, are above guarantee in nitrogen, available phosphoric acid and potash; twenty-six, or a little more than a fourth, are deficient in a single ingredient; seven, or one-twelfth, are deficient in two ingredients. Of the thirty-three brands found deficient, twenty-nine are but slightly so, or show by their analyses imperfect mixing at the factory. They contain a sufficient excess of other ingredients to afford an equivalent money value. It is safe to say that ninety-five per cent of the brands sold in the State this year contain the commercial equivalent of their guarantees.

The average composition of forty-seven brands sold in Vermont in 1894 and 1895 differs but slightly, the increase in valuation being but thirty-four cents. The average goods are of poorer quality than those sold before 1894. Owing to lower prices for mixed goods and the slight increase in valuation of the average of all goods, plant food is bought this year in commercial fertilizers as low as at any time within the past eleven years.

*** No attempt is made to summarize the portion of Bulletin 47 given under the heading "Fertilizers and Fertilization." The matter contained therein is so closely written that it does not admit of successful condensation.**

FERTILIZERS AND FERTILIZATION.

1. The principles governing the use of fertilizers.
2. The elements of plant food.
3. The specific action of nitrogen, phosphoric acid and potash upon vegetable growth.
4. The selection, purchase and use of commercial fertilizers.

I. PRINCIPLES GOVERNING THE USE OF FERTILIZERS.

The following clear and concise statement of the principles governing the use of fertilizers was made by the famous German chemist, Justus von Liebig, in 1840. Before that time fertilization was without a rational and scientific basis; since then no one has been able successfully to controvert his statements:

1. "A soil can be termed fertile only when it contains all the materials requisite for the nutrition of plants, in the required quantity, and in the proper form.

2. "With every crop a portion of these ingredients is removed. A part of this portion is again added from the inexhaustible store of the atmosphere; another part, however, is lost forever if not replaced by man.

3. "The fertility of the soil remains unchanged if all the ingredients of a crop are given back to the land. Such a restitution is effected by manure.

4. "The manure produced in the course of husbandry is not sufficient to maintain permanently the fertility of a farm; it lacks the constituents which are annually exported in the shape of grain, hay, milk and live stock."

2. THE ELEMENTS OF PLANT FOOD.

Chemistry has shown that all matter is composed of from sixty-five to seventy chemical elements (substances which thus far have not been divided into two or more different kinds of matter). It has also shown that but fourteen of these are necessary to animal and vegetable life. These fourteen essential elements naturally fall into two distinct classes, according to their sources.

1. AIR-DERIVED ELEMENTS:
   Carbon, Hydrogen, Oxygen, Nitrogen.
2. SOIL-DERIVED ELEMENTS:
   (*a*) *Phosphorus, Sulphur, Chlorin, Silicon.*
   (*b*) *Calcium, Iron, Potassium, Sodium, Magnesium, Manganese.*

The air-derived and first four soil-derived elements (*a*) are acid-forming elements; the last six soil-derived elements (*b*) are metals.

Soils usually contain enough of all these elements except *Nitrogen, Phosphoric Acid and Potash* to supply plant needs forever.

These, because of their ready exhaustion, are known as the ***deficient essential elements of plant food.*** They alone are the elements desired when direct fertilizers of any kind, natural or artificial, are applied.

We will therefore describe them in some detail.

NITROGEN.

Nitrogen occurs in nature—

(*a*) As a constituent of the air uncombined with other elements, a colorless, tasteless, odorless gas, forming about four-fifths of the bulk of the atmosphere.

(*b*) In the form of nitrates, combined with hydrogen and oxygen, forming nitric acid, which combining with metals forms salts.

(*c*) In the form of ammonia, combined with hydrogen, forming the colorless gas of familiar pungent odor. It is present in the air in very small quantities, and is formed by the decomposition of organic bodies containing nitrogen.

(*d*) In several forms of animal and vegetable matter, combined with carbon, hydrogen, oxygen, and sometimes small quantities of other elements; the fibrin of blood and flesh, casein of milk, albumen of white of egg, etc., are types of these materials.

PHOSPHORIC ACID.

Phosphorus occurs in nature combined with oxygen as phosphoric acid.

(*a*) In animal bones.

(*b*) In various mineral deposits.

(*c*) In soils and ores.

Pure phosphorus is a soft, yellow, waxy solid, poisonous and inflammable. Phosphoric acid usually is found combined with lime, iron or alumina.

There are four lime phosphates used in fertilizers, viz.:

(*a*) Mono-calcic phosphate, furnishing "soluble" phosphoric acid.

(*b*) Di-calcic phosphate, furnishing "reverted" phosphoric acid.

(*c*) Tri-calcic phosphate, furnishing "insoluble" phosphoric acid.

(*d*) Tetra-calcic phosphate, found in Thomas slag.

These phosphates have respectively one molecule or part of phosphoric acid united with one (mono-), two (di-), three (tri-) or four (tetra-) molecules or parts of lime (CaO). The third or tri-calcic phosphate is the only one found in nature, the other three being artificial products; it forms about one-half the weight of dry raw bone and forms from half to three-quarters the weight of many mineral phosphates.

The tri-calcic phosphate or insoluble phosphate of lime is but slowly available to the plant, for the phosphoric acid is firmly bound by the three molecules or parts of lime. It has been found, however, that if a stronger acid (sulphuric acid or oil of vitriol) is added in sufficient quantities to a lime phosphate, the grasp of two-thirds of the lime is transferred from the phosphoric to the sulphuric acid, thus loosening the bonds of the former and rendering it soluble. Two molecules or parts of the lime unite with the sulphuric acid to form sulphate of lime or gypsum, and the phosphoric acid remains held by but a single molecule or part of lime as mono-calcic phosphate. This mixture of mono- or soluble calcic phosphate and gypsum is what is known in the trade as superphosphate of lime; its phosphoric acid is readily soluble in water and is agriculturally in its most valuable form. If too little sulphuric acid is used, if the goods remain in piles before using, or if iron and alumina are present, more or less di-calcic or "reverted" phosphate is formed. This occurs at the time of manufacture if the sulphuric acid is short, or on standing in either of the other contingencies. This reverted form is not dissolved by water, but is soluble in certain chemicals, and is sufficiently soluble in root and soil acids to steadily nourish the growing plant. It is called "reverted" because much of it had once been soluble in water and had reverted or gone back to a relatively insoluble state. It is believed that much of the soluble phosphoric acid becomes reverted in the soil. The two forms are usually grouped together in trade parlance and spoken of as "available phosphoric acid" and have much the same agricultural and commercial value.

POTASH.

Potassium, which combines with oxygen to form potash (K_2O), is not found uncombined in nature, but occurs:

(*a*) As a constituent of many minerals.
(*b*) In various vegetable matters and their ashes.

Alone and uncombined it is a light, silvery metal.

It comes into fertilization—

(*a*) As chlorid in muriate of potash, kainit, etc.
(*b*) As sulphate in sulphate of potash, double manure salt, etc.
(*c*) As carbonate (and some silicate) in wood ashes, etc.
(*d*) As organic potash in cottonseed meal, tobacco stems, castor pomace, etc.

The first three forms are soluble in water; the fourth is only partially soluble, but is available on decomposition.

3. SPECIFIC ACTION OF NITROGEN, PHOSPHORIC ACID AND POTASH UPON PLANT GROWTH.

The effects of abundant supplies of the various deficient elements of plant food are usually shown as follows:

Nitrogen:—(*a*) Stem and leaf growth is favored, sometimes at the expense of perfect bud, flower and fruit development.

(*b*) The formation of chlorophyll (green coloring matter of the plant) is favored and the color deepened.

(*c*) The nitrogen in the plant and consequently its feeding value is increased.

Phosphoric Acid:—(*a*) Plant nutrition, particularly in early life, is favored, the mineral ingredients in general being better assimilated.

(*b*) Fruit and seed development are improved and maturity hastened.

Potash:—(*a*) Woody structure is better developed.

(*b*) Fleshy parts of fruit are improved in flavor and texture.

(*c*) The dissemination of starch through the structure of the plant is favored.

4. SELECTION, PURCHASE AND USE OF COMMERCIAL FERTILIZERS.

The average buyer of commercial fertilizers purchases on the strength of former personal experience, on the advice of neighbors, or on the representations of agents. He usually buys without definite knowledge of soil or crop needs. Under such circumstances a safe though often costly practice is to buy a so-called "complete" fertilizer furnishing nitrogen, phosphoric acid and potash. If, however, the soil or crop calls for but one or two of these, the third is needlessly bought.

The discriminating buyer should ask himself—

(*a*) Am I saving all the plant food in my home-made manure?

(*b*) If so, and I find I need more, shall I buy commercial fertilizers or feed my stock to the limit of healthful production and "fertilize by feeding"?

(*c*) If I must buy commercial fertilizers what constituents do I need?

(*d*) In what form shall I buy nitrogen, phosphoric acid and potash for my various crop and soil needs?

(*e*) Shall I buy complete factory mixed fertilizers, or crude stock and mix it myself?

Assuming (*a*) and (*b*) answered in a satisfactory manner and that commercial fertilizers must be bought.

(*c*) *What constituents are needed?*

Many farmers think that *soil analysis* will disclose soil needs. This belief though natural, is erroneous. Soil analysis fails for the following reasons:

1. No chemical solvent yet discovered can distinguish between available and insoluble soil ingredients. The chemist's acids dissolve both alike, while water on the other hand does not extract all that soil and root acids take up.

2. The character of the soil differs so widely even within a few feet as to render it difficult to take representative samples.

3. Past manuring, location of former manure heaps, etc., often make results obtained misleading.

Since soil analysis does not help, will the analysis of the crop be of use?

Many lay much stress upon plant analysis. The formulas of at least one make of special fertilizers sold largely in Vermont are based upon the analyses of the crops they are to fertilize.

The farmer may form some estimate of soil needs by watching his crops. A pale green leaf indicates a probable lack of nitrogen; a failure to form sound, plump, heavy grain indicates a probable lack of phosphoric acid. Plat tests with the different elements of plant food, singly and in combination, are often helpful. With this data in hand one may still find it best to buy a complete fertilizer but will usually purchase with more discrimination.

(*d*) ***The form in which to buy nitrogen, phosphoric acid and potash,*** either as complete fertilizer or as crude stock, depends on various conditions of soil and crop, and upon the especial objects in mind. For rapid effects, use as source of nitrogen, nitrate of soda or sulphate of ammonia; as source of phosphoric acid, use acid phosphate or bone black superphosphate, and for potash, muriate or sulphate of potash. For less rapid but steady growth use the better forms of organic nitrogen, acid phosphate or Thomas slag. For slower and more lasting effects, use bone or fish scrap (nitrogen and phosphoric acid) or, on soils rich in organic matter, the fine ground South Carolina rock, known to the trade as "floats," and wood ashes (potash). Leather, wool waste and ground phosphate rock should be used only when one is prepared to wait for years for returns.

The use of certain forms of fertilizing ingredients is desirable with some crops. Potatoes, tobacco and sugar beets do better on sulphate of potash than with the muriate, while with peach trees the reverse is true. Relatively insoluble forms of phosphoric acid are desirable in seeding down. Nitrate of soda is particularly adapted for top-dressing wheat and for the tomato.

If a complete fertilizer is bought designed for use on potatoes or tobacco, the buyer should note the form of potash claimed. It is fully as important, however, that he also note whether the station analyses show that the claim is made good.

(*e*) Practically all the commercial fertilizers bought in this State consist of so-called "complete" goods, factory mixed. In States further south, particularly those engaged more largely in market gardening (Rhode Island, Connecticut, New Jersey), the practice of "***home mixing***" has come largely into favor.

HOME MIXING.

Home mixing consists simply of buying the various fertilizing ingredients in the crude stock and mixing them at the farm. The phosphoric acid may be bought in the available form, thus obviating the necessity of handling sulphuric acid. These crude stocks are for sale and may be bought as readily as sugar or spices.

The system of home mixing has both advantages and disadvantages, and under many conditions is not applicable.

The advantages claimed are:

1. Reduced cost of fertilizers.
2. Definite knowledge of the nature of the plant food employed.
3. Special crop and soil needs may be met by special mixtures.
4. Indirect education in farm practice.

The disadvantages found are:

1. Close quotations are seldom given on small lots.
2. Vermont farmers, largely engaged in dairying, are not heavy buyers of commercial fertilizers.
3. Farmers may not make as even or fine mixtures as manufacturers can.
4. Greater convenience of purchase from dealers.

The first two of these disadvantages, namely, high quotations and small consumption, are caused by circumstances which must frequently prevent the adoption of home mixing.

The third disadvantage is completely answered by the facts, as many times determined, that whatever may or can be done by farmer or manufacturer, the farmer *does* make on the average as even and fine mixtures as the manufacturer.

Taking up the advantages in the order stated:

1. *Reduced cost.* A recent bulletin of the New Jersey Experiment Station shows that home mixtures representing 800 tons cost on the average $30.85 per ton, and that the fertilizing ingredients they contained, at station valuations, were worth $34.16, or $3.31 *more than cost*, *a gain of* 10.7 *per cent.* The average manufacturers' mixture made in 1894 sold at the point of consumption for $34.17, and had a station valuation of but $24.83, or in other words *cost* 37.6 *per cent more than the valuation.*

It should be noted, too, that the home mixtures were as fine and as evenly mixed as those made at the factories.

The direct comparison of analyses and valuations is instructive. It should be borne in mind that in case of the home mixtures the items of mixing, bagging and freight are not included as in the case of the manufacturers' mixtures. Fifty-five farmers estimate the first item to cost on the average 75 cents per ton.

Average Composition in 1894 of New Jersey.	Nitrogen.	Available Phos. Acid.	Insoluble Phos. Acid.	Potash.	Cost per ton.	Station Valuation.	Cost more or less than Valuation.
	%	%	%	%			
Manufacturers' Mixtures..	2.87	7.37	3.03	4.94	$34.17	$24.41	-$9.76
Home Mixtures.........	3.99	8.19	2.83	10.15	30.85	34.16	+3.31

In what way is this great reduction in cost obtained?

(*a*) Goods are bought in large lots for cash instead of in small quantities.

(*b*) Only high grade stock is bought, saving labor in mixing, bagging, selling expenses and freight on useless material.

(*c*) The expense of mixing, bagging and selling are eliminated.

(*d*) Advantages of market fluctuations may be taken, purchases made early in the year and mixtures made during the winter months.

2. ***Definite knowledge of kinds of plant food used.*** Each ingredient can be separately examined by the purchaser or by the Experiment Station for him, and its nature and quality determined. Leather, shoddy, wool-waste or other inferior materials cannot be palmed off as readily as when disguised by other ingredients in mixed goods.

3. ***Adaptation of formulas to special needs.*** The intelligent and observing farmer can better adapt his fertilizers to his crops and soils than the manufacturer who is ignorant of special needs. If it be urged that manufacturers make special brands for special crops, and that their long experience in the trade makes them better fitted to judge in this matter, it may be said in answer that manufacturers differ widely among themselves as to crop requirements as shown in the composition of the so-called "special" fertilizers. For instance, in the present bulletin we find eight brands of corn fertilizers with guarantees ranging from 1.0 to 3.3 per cent nitrogen, from 7.5 to 9.5 per cent available phosphoric acid and from 1.5 to 7.5 per cent potash; and twenty-four brands of potato fertilizers with guarantees ranging from 1.0 to 3.3 per cent nitrogen, from 4 to 10 per cent available phosphoric acid and from 1.85 to 9 per cent potash. The range in each case is wide enough to suit the most fastidious, yet each brand, if we may believe the claims made for it, is mixed especially to supply the special needs of the crop named. It is probable that if by mistake a "potato manure" fertilized a piece of corn, and the potato patch was dressed with a "corn fertilizer" the results would not be materially different. This probability becomes certainty in cases where guarantee and analysis of different brands of the same company show that the goods are identical, or in other words, that they have been shoveled from the same pile. Stencils are cheap and too often a new stencil, an ink pot and brush made a new brand of fertilizer. A multiplicity of brands is not of necessity an indication of a healthy fertilizer trade. It is probable that the Vermont farmer would be just as well served by a quarter part of the brands now sold in the State as by the ninety or more now on sale.

The kind, quality and amounts of nitrogen, phosphoric acid and potash in a fertilizer are the measure of its value, while names and rival claims are of little significance in comparison with this standard. The value of certain proportions of the fertilizing ingredients for certain crops is not as plain, however.

A careful comparison of (1) guarantees, (2) station analyses and valuations, (3) selling prices, (4) soil and crop conditions, and (5) the market prices of crude stock, is the best course for the buyer to follow. This study being made he can choose the complete fertilizer more intelligently, or if circumstances warrant it can buy crude stock and mix to advantage himself.

4. *Indirect education.* The indirect educational value of this practice is of much benefit. It promotes inquiry, investigation, study, and leads to more intelligent and more profitable work.

What is the experience of practical and successful farmers with home mixing? The New Jersey bulletin already quoted, gives interesting data on this point. It says: "Many farmers have adopted this method of purchasing their supplies, and their experience, particularly in the making and using of home mixtures, which in many cases now covers a series of years, has been reported to the station. These farmers, numbering sixty, are making farming their business, and are among the most successful in the State.

(*a*) Three report having used home mixtures for 20 years; twelve from 10 to 12 years; twenty-three from 5 to 10 years; seventeen from 2 to 5 years; and five, this as their first year.

(*b*) Seven farmers use over 25 tons per year—one as high as 40 tons; sixteen use 15 tons or more; fourteen use 10 to 15 tons; sixteen use 5 to 10 tons, and six less than five tons.

(*c*) Forty-two of the sixty use more now than when they began; five, three to four times as much, and eleven about the same quantity, varying according to the area of the best paying crop.

(*d*) Fifty-four state that they do not have any difficulty in getting good mixtures; four had some difficulty at first, while one states that his home mixtures excel in mechanical condition any manufactured brand he has ever used.

(*e*) Considerable variation is reported in the cost of mixing; two report an expense of $1.50 per ton; fifteen say that it cost $1 per ton; sixteen estimate the cost at 75 cents; nineteen at 50 cents; one at 60 cents; two at 25 cents, and two do not regard the mixing as an extra cost. They all report the mixing as being done by the ordinary labor of the farm, when other work is not pressing, and therefore no extra expenditure.

(*f*) Fifty-four farmers report that the results are thoroughly satisfactory, both in regard to the yield and the quality of crop. Five report this year as their first year, though their crops are looking quite as well as where other brands were used.

(*g*) Fifty-three state that it pays them well to buy raw materials and mix for themselves; five have not yet secured results, and one thinks he can do about as well in buying the regular brands.

(*h*) With two exceptions all agree that the main advantage derived is that the actual constituents cost much less than in the same grade of goods purchased either directly from manufacturers or from dealers. Twenty-six state that the saving is from $6 to $10 per ton, and that further advantages are—

First, that they know exactly what they are using; second, that they can use the best forms of plant food; third, that the essential constituents can be varied to suit the requirements of various soils and crops.

One farmer reports that the third point alone has been of the greatest service to him, enabling him to make profitable, crops which were formerly considered almost impossible to raise.

But three farmers report any disadvantage. One states that there is considerable loss from handling; another that it is difficult to procure the materials in small quantities at a reasonable price, while a third considers it a disadvantage to pay cash.

The above summary of the practical experience of farmers is, perhaps, sufficient evidence of the value of home mixing, and the strongest argument that could be presented for the adoption of this method of purchasing supplies.

The main conditions to be observed, and which are necessary, in order to make the method entirely feasible and truly economical, are: First, that the supplies should be purchased in considerable quantities; second, that they should be purchased early, and prepared before the beginning of the busy season on the farm; third, that contracts should be on a cash basis."

How is Home Mixing done? A tight barn floor, platform scales, screen, shovel and hoe, are the only utensils needed. The materials being weighed, screened, and lumps pulverized, the most bulky stock is spread in an oblong pile from 6 to 12 inches deep; upon its leveled top the next material is placed, and so on until all have been added like layers on a layer cake. Commencing at one end the pile is shoveled over, reaching clear to the bottom every time. The pile is then leveled up and the operation repeated three times. The mixture may then be screened again if desired.

Is Home Mixing adapted to Vermont farm conditions? Our farmers seldom use large quantities of commercial fertilizers, but farmers' clubs, granges, etc., might find it advantageous to buy crude stock in car load lots and mix to suit individual needs.

The following is a form, taken with slight changes, from a circular sent to dealers in fertilizing chemicals by a New Jersey grange, which may prove suggestive to any contemplating home mixing in this State:

"Wanted—To buy the materials to make......tons or more of fertilizer. The materials to consist of nitrate of soda, sulphate of ammonia, acid phosphate, dissolved bone or bone black, fine ground bone, fine ground fish scrap, muriate of potash and sulphate of potash. All materials to be in good mechanical condition; in good bags; to run even weights or be plainly marked what each bag contains net, and to be delivered at........early in March next. All materials to be guaranteed to contain certain percentages of nitrogen, potash or available phosphoric acid, as the case may be; one-half of the bill to be paid within ten days after receipt of goods; on the other half a credit of sixty days to be allowed, within which time samples will be sent to the Vermont Experiment Station for analysis, and if there found to contain as large percentages as guaranteed, the balance of the bill will be paid within the sixty days, but if any are found to contain a less percentage than guaranteed, then a discount is to be allowed on the bill equal to the loss in money value caused by such deficiency for the first one per cent or fraction thereof, and twice the loss in money value for all deficiencies in excess of one per cent, and balance of bill within the sixty days. Samples to be taken by a station agent or other disinterested party."

The Experiment Station stands ready to aid with advice and analysis all who desire to try home mixing.

It should be noted that purchasers of unmixed chemicals for personal use do not violate the State fertilizer law which does "not affect parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in this State."

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ANALYSES OF LICENSED FERTILIZERS.

Station Number.	BRAND.	NITROGEN.						PHOSPHORIC ACID.								POTASH.			Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Valuation at Station Prices.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Valuation at Station Prices.	Found.	Guaranteed.	Valuation at Station Prices.	
1533	Bowker's Farm and Garden Phos	0.86	- - -	1.05	1.91	1.6	$6.05	4.00	3.64	5.67	13.31	10.	7.64	8.	$11.07	1.95	2.	$1.78	1533
1521	“ Hill and Drill Phosphate	0.54	0.23	2.03	2.80	2.5	9.17	6.93	2.34	3.59	12.86	12.	9.27	9.	12.33	2.29	2.	2.06	1521
1522	“ Stckbdg. for Potat's, &c.	1.43	- - -	1.81	3.24	3.25	10.26	6.28	2.39	2.20	10.87	8.	8.67	6.	11.05	7.37	7.	6.63	1522
1504	Bradley's Corn Phosphate	- - -	- - -	2.28	2.28	2.05	7.52	6.91	2.25	2.34	11.50	10.	9.16	9.	11.70	2.02	1.5	1.82	1504
1502	“ Eclipse Phosphate	- - -	0.13	2.15	2.28	1.	7.68	6.61	2.93	2.32	11.86	12.	9.54	10.	12.08	1.86	1.5	1.67	1502
1503	‘ Potato Fertilizer	0.22	0.18	1.88	2.28	2.05	7.53	6.05	2.76	2.48	11.29	11.	8.81	9.	11.29	3.38	3.25	3.04	1503
1523	“ Potato Manure	0.21	0.16	2.16	2.53	2.5	8.36	3.92	2.19	2.29	8.40	8.	6.11	6.	8.03	5.31	5.	4.78	1523
1501	“ X. L. Superphos. of Lime	0.44	0.18	1.91	2.53	2.5	8.29	7.00	2.56	1.72	11.28	11.	9.56	9.	11.91	2.58	2.	2.32	1501
1530	Cleveland Corn and Grain Phos.	0.48	0.14	1.80	2.42	2.05	7.90	6.15	2.87	2.61	11.63	10.5	9.02	9.5	11.58	1.90	1.5	1.71	1530
1505	“ Fertilizer for all Crops	- - -	- - -	1.53	1.53	1.05	5.05	6.06	2.07	2.00	10.13	9.	8.13	8.	10.35	2.16	2.	1.94	1505
1527	“ Potato Phosphate	- - -	0.13	2.01	2.14	2.05	7.11	5.96	2.81	2.16	10.93	10.	8.77	8.	11.10	3.23	3.	2.91	1527
*1532	Coe's Ammo. Bone Superphosphate	- - -	0.16	1.65	1.81	1.25	6.05	7.42	1.99	2.87	12.28	9.	9.41	8.	12.24	1.60	1.35	1.62	1532
*1518	“ Columbian Potato Fertilizer	- - -	- - -	1.60	1.60	1.	5.28	7.34	1.88	3.31	12.53	11.	9.22	9.	12.20	1.74	1.85	1.76	1518
*1525	“ Columbian Corn Fertilizer	- - -	0.16	1.38	1.54	1.	5.15	7.05	2.42	3.04	12.51	11.	9.47	9.	12.34	1.86	1.85	1.89	1525
*1531	“ Grass and Grain Fertilizer	- - -	- - -	1.11	1.11	0.8	3.66	6.62	3.17	3.82	13.61	10.	9.79	9.	12.96	1.64	1.35	1.68	1531
1507	Crocker's Ammo. Corn Phosphate	- - -	0.16	2.02	2.18	2.	7.26	7.56	2.63	1.63	11.82	11.	10.19	10.	12.62	1.92	1.6	1.73	1507
†1508	“ New Rival Ammo. Sup.	- - -	- - -	1.44	1.44	1.2	4.75	6.83	3.39	1.35	11.57	11.	10.22	10.	12.47	1.81	1.6	1.73	1508

*Potash in brands thus marked is in form of sulphate ; in all others except 1508 it is in the form of chlorid (muriate). †Part of the potash in this brand is in the form of sulphate.

ANALYSES OF LICENSED FERTILIZERS.

Station Number.	BRAND.	NITROGEN.						PHOSPHORIC ACID.								POTASH.			Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Valuation at Station Prices.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Valuation at Station Prices.	Found.	Guaranteed.	Valuation at Station Prices.	
1506	Crocker's Potato, Hop & Tobacco.	- --	0.18	1.92	2.10	2	$7.00	7.89	2.28	1.17	11.34	11	10.17	10	$12.44	3.52	3.2	$3.17	1506
1519	" Superior Rye & Oats Phos.	-- -	- --	1.34	1.34	0.82	4.42	5.84	2.52	2.44	10.80	9	8.36	8	10.76	1.98	2	1.78	1519
1509	Cumberland Potato Fertilizer	0.44	0.13	1.54	2.11	2.05	6.88	5.33	3.18	2.94	11.45	11	8.51	9	11.07	3.33	3	3.00	1509
1524	" Superphosphate	0.21	0.16	2.06	2.43	2.06	8.02	6.78	2.34	1.77	10.89	10	9.12	8	11.42	2.36	2	2.12	1524
1528	Lister's Special Potato Fertilizer	-- -	0.28	1.61	1.89	1.64	6.35	6.13	2.35	2.51	10.99		8.48	8	10.95	2.90	3	2.61	1528
1510	" Success Fertilizer	- --	0.27	1.38	1.65	1.25	5.55	7.50	1.49	2.67	11.66		8.99	9	11.71	2.01	2	1.81	1510
1511	P. G. Co's Soluble Pacific Guano	- --	0.18	2.19	2.37	2.25	7.89	6.90	1.81	1.80	10.51	10.5	8.71	8.5	10.99	2.53	2	2.28	1511
1512	" Special Potato & Tobac.	0.52	- --	1.79	2.31	2.	7.47	6.04	2.23	2.46	10.73	9	8.27	8	10.69	3.27	3	2.94	1512
1515	Quinnipiac Climax Phosphate	- --	- --	1.27	1.27	1.03	4.19	6.50	1.71	1.44	9.65	9	8.21	8	10.26	2.54	2	2.29	1515
1513	" Corn Manure	0.24	0.14	1.84	2.22	2.06	7.31	6.14	2.85	2.43	11.42	10	8.99	9	11.48	1.94	1.5	1.75	1513
1514	" Potato & Tobacco Fert.	0.38	0.13	1.80	2.31	2.05	7.56	5.97	2.18	2.57	10.72	9	8.15	8	10.59	2.85	3	2.57	1514
1526	Read's Leader Guano	0.17	- --	1.01	1.18	0.82	3.84	4.50	2.32	1.44	8.26	8	6.82	7	8.53	2.43	2	2.19	1526
1529	" Standard Superphosphate	0.22	- --	1.01	1.23	0.82	3.99	6.04	1.93	1.09	9.06	10	7.97	8	9.81	4.09	4	3.68	1529
1516	W. & C. Co.'s Ammo. Corn Phos.	0.35	0.13	1.80	2.28	2.05	7.47	6.19	2.66	2.65	11.50	10	8.85	9	11.41	1.72	1.5	1.55	1516
1520	" Ammo. Potato & Tobac.	- --	0.14	2.03	2.17	2.05	7.22	6.17	2.83	2.45	11.45	9	9.00	8	11.50	3.17	3	2.85	1520
1517	" Royal Bone Phosphate	- --	- --	1.32	1.32	1.03	4.36	6.12	1.60	1.77	9.49	8	7.72	7	9.82	2.56	2	2.30	1517

ANALYSES OF LICENSED FERTILIZERS.

Station Number.	BRAND	NITROGEN.						PHOSPHORIC ACID.								POTASH.			Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Valuation at Station Prices.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Valuation at Station Prices.	Found.	Guaranteed.	Valuation at Station Prices.	
1550	Bowker's Corn Phosphate..	0.49	....	1.32	1.81	1.5	$5.83	3.99	3.62	5.89	13 50	11.	7.61	9.	$11.13	1.98	2.	$1.78	1550
1870	“ Fish and Potash..	0.43	....	0.67	1.10	0.75	3.50	4.97	2.19	6.59	13.75	9.	7.16	6.	11.01	1.02	1.	0.92	1370
1371	“ Grain FodderCorn	1.16	....	2.08	3 24	3.25	10.34	7.99	2.19	2.36	12 54	10.	10 18	8.	12.94	4.57	4.2	4.11	1371
1348	“ Potato, Vegetable	0.55	0.23	1.89	2.67	2.5	8.74	7.21	2.06	2.89	12.16	10.	9.27	8.	12.07	4.94	4.	4.45	1348
1538	“ Potato Phosphate.	0.46	....	1.43	1.89	1.5	6.10	5.52	2.88	4.43	12 83	10.	8 40	8.	11.56	2.21	2.	1.99	1538
1551	“ Sqr. Br. Bone Pot.	....	....	1.69	1.69	1.64	5.58	1.95	5.20	9.65	16.80	12.	7.15	6.	11.92	3.23	2.	2.91	1551
1536	“ Stockb'ge for Corn	1.25	....	2.11	3.36	3.25	10.71	7.70	2.33	2.50	12.53	10.	10.03	8.	12.80	4 80	4.	4.32	1536
1535	“ “ Seed'g Down	1.07	....	1.43	2.50	2 5	7.93	5.42	1.91	4.82	12.15	12.	7.33	6.	10.53	10.89	10.	9.80	1535
1422	“ “ Strawberries	0.77	....	1.84	2.61	2.5	8.38	7.14	2.95	3.87	13.96	7.	10.09	6.	13.36	4.27	4.	4.40	1422
1534	“ “ Top Dressing	2.20	....	3.18	5.38	5.	17.09	3.78	1.79	3.33	8 90	6.	5.57	4.	7.84	6.34	6.	5.71	1534
1537	“ Sure Crop Phos'te	0.29	....	0.87	1.16	0.75	3.74	2.38	4.99	6.04	13.41	10.	7 37	8.	10 76	1.14	1.	1.03	1537
1411	“ Super with Potash	-- -	....	....	....	---	....	2.98	6.31	3.28	12.57	12.	9.29	10.	11 83	1.89	1.	1.70	1411
1421	“ 10 per cent Manure	0.44	....	0.77	1.21	0.82	3.86	0.60	3.29	6.46	10.35	8	3.89	6.	8.00	10.53	10.	9.47	1421
1539	Bradley's B. D. Sea Fowl Gu	....	....	2.16	2.16	2.05	7.13	6.98	2.59	1.79	11.36	10.	9 57	8.	11.94	2.12	1.5	1.91	1539
1552	“ Complt Pot & Veg	0.85	0.11	2.52	3.48	3.7	11.27	4.84	3.69	2.78	11.31	9	8 53	8.	10.98	5.77	6.	5.19	1552
1417	“ “ Top Dress	2.44	....	2.65	5.09	4.95	16 07	1.40	3.76	1.54	6.70	6	5 16	5.	6.43	3.70	2.5	3.33	1417
†1221	“ Gr Bone & Potash	0.69	....	1.75	2.44	1.85	7 85	4.09	1.64	6.10	11.83	8.	5.73		9.15	2.80	2.	2.84	1221
1345	“ Seed Down Manure	0.34	0.12	2.41	2.89	2.5	9.42	6.85	2.37	1.69	10.91	12.	9.22	7.	11.51	2.45	2.	2.20	1345
1276	Clarks Cove Bay State G. G.	....	....	2.28	2 28	1.85	7 52	7.22	1.59	1.19	10.00	10.	8.81	8.5	10.89	2.70	2.	2.43	1276
1277	“ Potato and Tobacco ..	....	....	2.16	2.16	2.05	7.13	4.85	3.26	3.17	11.28	9.	8 11	8.	10 67	3.37	3.	3.03	1277

†Potash in brands thus marked is in form of sulphate; in all others it is in the form of chlorid (muriate).

ANALYSES OF LICENSED FERTILIZERS.

		NITROGEN.						PHOSPHORIC ACID.								POTASH.			
Station Number.	BRAND.	From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Valuation at Station Prices.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Valuation at Station Prices.	Found.	Guaranteed.	Valuation at Station Prices.	Station Number.
§1540	Cleveland Superphosphate	- - -	0.11	2.15	2 26	2.05	$7.51	6.88	2.37	1.25	10.50	11	9.25	9	$11 36	2.52	2	$2 27	1540
1542	Coe's Celebrated Special Potato	- - -	- - -	2.05	2.05	1.65	6.77	7.77	2.33	2.00	12.10	11	10.10	9	12.69	3.24	3.5	3.37	1542
§1548	" Columbian Ammo. Bone	- - -	0.13	1.69	1.82	1.	6.06	7.22	1.98	3.34	12.54	11	9.20	9	12.18	1.90	1.85	1.94	1548
1541	" Excelsior Potato Fert†	- - -	0.38	2.42	2.80	3 3	9.40	5.97	1.09	0.94	8.01		7.07	7	8.74	8.70	9	9.11	1541
§1389	" Gold Brand Excelsior Gu	- - -	0.80	1.78	2.58	2 5	8.83	6.79	1.68	2.65	11.12	9	8.47	8	11.06	5.24	6	5.40	1389
1239	" High Grade Ammo. Bone	- - -	0.14	2.02	2.16	2.	7.19	7.45	1.85	2.59	11.89	11	9.30	9	12.02	1.87	1.85	1.89	1239
§1233	" High Grade Potato Fert	- - -	0.31	2.00	2 31	2.05	7.75	6.40	1.65	2.60	10 65	9	8.05	8	10.53	5.02	6	5.20	1233
§1553	" Red Brand Excelsior Gu	- - -	0.46	2.92	3.38	3.5	11.34	6.36	1.49	1.25	9 10	10	7.85	9	9.77	6.16	5.94	6.36	1553
1209	Cumberland Fertilizer	- - -	- - -	1.30	1.30	1.03	4.29	6.03	1.66	1.40	9.09	10	7.69	8	9.63	2.59	2.6	2.33	1209
1220	" Seed Down Fert	- - -	- - -	1.42	1.42	1.23	4.69	5.54	2.53	1.96	10.03	12	8.07	8	10.22	2.47	2	2.22	1220
1273	Great Eastern Grain, Grass	0.32	0.11	2.46	2.89	2.47	9.49	6.86	1.10	1.13	9.09	9	7.96	8	9.89	2.38	2	2 14	1273
1242	" " Grass and Oats	- - -	- - -	- - -	- - -	- - -	- - -	8.61	3.23	2.38	14.22		11.84	11	14.85	1.57	2	1.41	1241
1272	" " Oats, Seeding	0.17	- - -	1.03	1.20	0.82	3.91	6.44	1.15	0.94	8 53	9	7.59	8	9.37	3 86	4	3.47	1272
‡1275	" " Sol. Bone & Pot	- - -	- - -	- - -	- - -	- - -	- -	6.58	1.62	2.00	10 20		8.20	10	10.48	2.49	4	2.24	1275
1543	" " Veg. Vine & Tob.	0.27	0.11	1.71	2.09	2.05	6 86	4.00	4.43	0.83	9 26	9	8.43	8	10.00	4.41	3.25	3.97	1543
1382	" " Wheat Special	- - -	0.21	1.48	1.69	1.64	5.66	1.47	7.31	1.50	10.28	9	8.78	8	10.41	2.18	2	1.96	1382
1544	Lister's Animal Bone Potash	- - -	- - -	- - -	- - -	- - -	- - -	7.00	2.22	0.67	9.89	10	9.22	9	11.11	4.99	5	4.49	1544
1554	" Potato Manure	- - -	- - -	- - -	3.72	3.7	12.28	6.32	1.64	1.38	9 34		7.96	7.5	9.94	7.52	7	6 77	1554
1403	" Corn Manure	0.66	0.43	2.49	3.48	3.29	11.79	6.38	1.27	1.38	9.03		7.65	7.5	9.61	7.64	7	6.88	1403
1545	" Potato Fertilizer No. 2	- - -	0.21	2 37	2.58	1.81	8 60	7.64	2.21	2.06	11.91		9.85	9.2	12.42	3.97	4	3.57	1545

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†The manufacturers claim that the guarantee is incorrectly stated on the bags in the two shipments from which the sample was taken; that the correct guarantee is nitrogen 2.47 per cent, available phosphoric acid 8 per cent, potash 8 per cent.

‡The manufacturers claim that the guarantee is incorrectly stated on the bags from which this sample was taken, and that the correct guarantee is available phosphoric acid 11 per cent., potash 2 per cent.

§ Potash in brands thus marked is in form of sulphate; in all others it is in the form of chlorid (muriate.)

ANALYSES OF LICENSED FERTILIZERS.

Station Number.	BRAND.	NITROGEN.						PHOSPHORIC ACID.								POTASH.			Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Valuation at Station Prices.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Valuation at Station Prices.	Found.	Guaranteed.	Valuation at Station Prices.	
1270	Pac. Gu. Co's Nobsque Guano	- --	- --	1.33	1.33	0.91	$4.39	4.63	2.93	2.85	10.41		7.56	9.	$ 9.92	2.42	2.	$2.18	1270
1261	Powers, Gibbs & Co.'s Almont	- --	0.11	1.06	1.17	0.82	3 91	6.79	2.08	2.75	11.62		8.87	8.	11.54	3.22	3.	2.90	1261
1260	" " Sea Bird	- --	- --	1.81	1·81	1.23	5.97	7.75	1.86	1.97	11.58		9.61	8.	12.13	2.67	2.	2.40	1260
1262	" " Spec. Pot	- --	- --	2.25	2.25	2.05	7.43	7.73	0.84	0.43	9.00		8.57	8.	10.37	8.21	8.	7.39	1262
1263	" " Spec. S.G	- --	- --	1.04	1.04	0.82	3 43	6.25	2.79	3.12	12.16		9.04	8.	11.82	1.99	2.	1.79	1263
1473	Quinnipiac Mkt Grdn Manure	0.99	- --	2.48	3.47	3.3	11 15	4.52	3.97	2.68	11.17	9.	8.49	8.	10.86	6 59	7.	5.93	1473
1229	" Phosphate	0.53	- --	2.52	3.05	2.47	9 91	6.95	1.91	1.70	10.56	10	8.86	9.	11.12	2.58	2.5	2.32	1229
1228	" Potato Manure...	0.37	0.12	2.02	2.51	2.47	8.22	3.96	1.95	2.49	8.40	7.	5.91	6.	7.90	4.82	5.	4.34	1228
1555	Read's Fish, Bone and Potash	- --	0.12	2.51	2.63	2.47	8 73	3.16	1.74	0.97	5.87	6.	4.90	4.	6.10	4.91	4.	4.42	1555
1286	" Farmer's Friend.....	0.82	- --	1.49	2.31	2.05	7.38	6.61	2.32	0.77	9.70	10.	8 93	9.	10.79	2.18	2.	1.96	1286
†1556	J. S. Reese & Co.'s Pacific Gu	- -	0.16	1.88	2.04	1.89	6.80	3.72	6.22	1.65	11.59	10.5	9.94	8.5	11.97	1.47	1.2	1.41	1556
1557	" " Potato Phos	- --	- --	2.05	2.05	2.05	6 77	5.50	4.01	2.29	11 80	9.5	9.51	8.5	11.93	5 31	6.	4.78	1557
1558	" " Standard ...	- --	- --	2.22	2.22	2.47	7.33	4.55	5.37	2.35	12.27	10.	9.92	9.	12.31	2.08	2.	1.87	1558
1280	Standard A Brand..........	- --	- --	1.55	1.55	1.23	5.12	5.89	1.98	2.21	10.08		7.87	8.	10.13	1.92	2.	1.73	1280
1278	" Fertilizer..........	0.29	- --	2.00	2.29	2	7.47	5.73	2.41	2.16	10.30	10.	8.14	8.	10.38	2.36	2.	2.12	1278
1546	" Guano..............	0.22	- --	1.26	1.48	1	4.82	6.30	2.01	1.35	9.66	10.	8·31	8.	10 31	2.43	2.	2.19	1546
1298	" Potato and Tobacco	0.58	- --	1.67	2.25	2.05	7.25	5.36	3.10	2.54	11 00	9.	8.46	8.	10.86	3.36	3.	3.02	1298
1224	W. & C. Co.'s Ammo. Bone..	0.35	0.13	2.34	2.82	2.47	9.25	6.37	2.82	1.76	10.95	10.	9.19	9.	11.44	2.55	2.	2.30	1224
†1547	" Potato Phos...	0.95	- --	2.05	3.00	2.47	9.61	4.47	1.61	1.87	7.95	7.	6.08	6.	7.89	5.35	5.	4.99	1547

†Potash in brands thus marked is partly in form of sulphate; in all others it is in the form of chlorid (muriate).

COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1894 AND IN 1895.

Of the ninety-seven brands of commercial fertilizers sold in the State during 1894 and 1895, and found by our sampling agents, forty-seven standard brands have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands were selected which have been found by us both of the years.

AVERAGE COMPOSITION OF FERTILIZERS IN 1894 AND 1895.

NAME OF INGREDIENTS.	1894.		1895.	
	Pounds in a Hundred.	Valuation at 1895 Prices.	Pounds in a Hundred.	Valuation at 1895 Prices.
Nitrogen..	2.24	$7.39	2.24	$7.39
Soluble Phosphoric Acid..	5.24	6.29	5.90	7.08
Reverted Phosphoric Acid	3.04	3.34	2.47	2.72
Insoluble Phosphoric Acid	2.18	0.87	2.35	0.94
Available Phosphoric Acid	8.28		8.37	
Total Phosphoric Acid....	10.46		10.72	
Potash......	2.99	2.69	3.10	2.79
Total valuation per ton...		$20.58		$20.92

A comparison of the average compositions for 1894 and 1895 in the above table shows but little change. The increase in valuation amounts to but thirty-four cents. It was noted of last year's goods that "the average composition is much lower than that of any previous year since the station began sampling and analyzing licensed fertilizers under the State law." The lower grade of the goods now sold, as compared with those sold earlier, is seen on reference to the table on page 34. The increase in potash over former years is due to the sale of several brands containing from 7 to 10 per cent of this ingredient.

The average of analyses, selling prices, valuations, percentages of increase of cost over valuation,* and valuations of all at 1885 and at 1895 trade values of all the brands analyzed each year since the Experiment Station has been in existence are shown in the following table:

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*The percentage of increase of cost over valuation. Example—1885 brands cost $37.90, valuation $26.72; $37.90—$26.72=$11.18; $11.18÷$26.72=42 per cent, i. e. $11.18 is the increase of the cost over the valuation, and 42 is the percentage of the same.

AVERAGE ANALYSES OF ALL BRANDS.

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Nitrogen	2.38	2.58	2.75	2.80	2.55	2.41	2.52	2.42	2.41	2.21	2.22
Sol. Phos. Acid	6.35	6.15	5.48	6.74	6.68	5.99	6.47	6.47	6.44	5.42	5.84
Rev. "	1.93	1.92	3.23	2.80	2.97	2.97	2.86	2.60	2.84	2.97	2.56
Insol. "	2.13	2.59	2.52	2.56	2.98	2.71	2.00	2.18	2.34	2.16	2.53
Avail. "	8.28	8.07	8.71	9.54	9.65	8.96	9.33	9 07	9.28	8.39	8.40
Total "	10.41	10.66	11.23	12.10	12.63	11.67	11.33	11.25	11.62	10.55	10.93
Potash	2.77	2.69	2.84	3.12	2.69	3.16	3.13	2.82	2.64	2.95	3.46
	$	$	$	$	$	$	$	$	$	$	$
Av. sell'g pr'ce	37.90	37.02	36.75	35.13	35.11	34.39	33.14	32.47	32.32	31.47	30.90
Av. valua'n by each y'rs p'ce	26.72	25.75	27.15	28.96	29.05	26.70	26.07	24.48	23.53	21.47	21.28
Per ct. incr'se cost over val.	42.	44.	35.	21.	21.	29.	27.	33.	37.	47.	45.
Val. by '85 p'cs	26.72	27.21	28.86	30.88	30.03	28.52	29.16	28.22	28.46	25.84	26.25
Val. by '95 p'cs	20.94	21.46	22.77	24.24	23.31	22.23	22.84	22.02	22.13	20.59	21.28

Although the best goods were sold in 1888-89, it does not follow that more plant food was bought for a dollar then than now, since both crude stock and mixed goods have fallen in price. Last year the showing was not favorable. "The plant food which cost a dollar in 1894, cost ninety-four cents in 1888." The table given above shows that this year's goods cost on the average 57 cents less per ton and valued (at 1895 prices) 69 cents more per ton, or in the standard goods (see upper table) 34 cents more per ton. This is sufficient to turn the scale. The plant food which cost a dollar in 1895, cost the same in 1888, and a dollar and a quarter in 1885. In other words the Vermont buyer pays as low for commercial fertilizers in 1895 as at any time before. But if former prices were fair he should pay less than ever before, because of the present low prices of fertilizing ingredients in crude stock. From 1889 to 1895 the average selling price has fallen $4.21 or 12 per cent, the average valuation, $7.70, or 29 per cent. In other words the decrease in the selling price has not been proportionate to the decrease in the actual cost of crude stock.

The wide percentage of increase of cost over valuation in 1894 and 1895 should be noted. It is a serious question to the large buyer whether he can afford to pay 45 per cent of the gross cost of the plant food he buys for the items of mixing, bagging, freight and selling. The home mixing system (see pages 24-27) has much to recommend it to such a person.

Bulletin No. 48—Gluten Feeds and Meals.

By J. L. Hills.

SUMMARY.

1. Gluten feeds and meals are by-products of glucose manufacture from corn. The bulk of the starch is removed, thus relatively increasing the protein or flesh-forming portions and the fat.

2. The various gluten feeds consist of the entire dried waste products of this manufacture. Being rich in protein and fat and containing the bran of the corn, which lightens the mass and improves its physical condition, they are well adapted for dairy feeding, and may be fed with comparative safety.

3. The various gluten meals contain neither the bran nor the germ, and are much richer than the gluten feeds. They should be fed with more care because of their concentration.

4. The corn germ residues are comparatively rich, while the brans are poor.

5. Feeding tests made at this station tend to show that Cream and King gluten meals have a decidedly greater, Chicago Maize feed a somewhat greater, and Corn Germ feed the same feeding value as equal weights of bran and corn meal.

6. These feeds also seemed to produce a very slightly richer milk, one in which the fat is disproportionately increased.

Bulletin No. 49—Potato Blights and Fungicides.

By L. R. Jones.

SUMMARY.

I. The late blight attacked potatoes in 1895 two weeks later than might be expected, judging from the condition of weather alone. This delay was due to the unusual freedom from rot of "seed" potatoes grown in the dry summer of 1894. It is probable that similar results might be secured every year if healthy seed potatoes were selected entirely from fields of early potatoes which escaped the late blight.

II. Comparative trials of various forms of the liquid Bordeaux mixture and of the dry Bordeaux powders were made in 1895. The results show that the freshly made liquid mixture of standard strength is superior to all others. By its use the yield of marketable potatoes on the trial plots was more than doubled.

For the best way to make Bordeaux mixture, see page 88 of the bulletin and Report of the Botanist in this volume.

III. The term "blight" is popularly applied to the premature dying of potato leaves from any cause. Successful treatment of any disease requires that the cause be distinctly understood.

The chief potato leaf diseases are:

1. The Late Blight (or mildew) and Rot. Cause, the fungus Phytophthora infestans.

Preventive measures: Plant tubers free from the disease, and make two or three applications of Bordeaux mixture.

2. The Early Blight (or leaf-spot disease). Cause, the fungus Macrosporium Solani, usually attacking weakly plants.

Preventive measures: Increase the general vigor of the plants by selection of varieties, better preparation, fertilization and cultivation of the soil, and later planting; spray with Bordeaux mixture.

3. Arsenical poisoning. Cause, improper use of Paris green, etc.

Preventive measures: Apply smaller amounts of the Paris green dry and diluted with plaster, or add lime to the water, if this is used as a carrier of the poison.

4. Tip Burn. Cause, dry hot weather, aided by any other conditions unfavorable to the plant.

Preventive measures: Increase the general vigor of the plant as in No. 2, and irrigate during dry weather, if practicable.

IV. Late frosts in the spring of 1895 caused a serious russeting of the surface of apples and pears.

REPORT OF THE CHEMISTS.

By J. I. Hills and B. O. White.

ANALYSES OF MISCELLANEOUS FERTILIZERS.

Analyses of Fertilizer Crude Stock.

Station Number.	MATERIAL.	RECEIVED FROM	Nitrogen.	PHOSPHORIC ACID. Soluble.	PHOSPHORIC ACID. Reverted.	PHOSPHORIC ACID. Insoluble.	PHOSPHORIC ACID. Total.	PHOSPHORIC ACID. Available.	Potash.
		Nitrogenous and Phosphatic.							
1560	Tankage..........	Great Eastern Fert. Co., Rutland	8.26				9.85		
1599	"	Robertson & Shiland, Burlington	4.11				11.51		1.24
1600	"	" " "	4.24				14.74		
1608	"	" " "	3.60				13.50		
1609	"	" " "	3.10				11.80		
1561	Ground Bone....	Great Eastern Fert. Co., Rutland	4.22				25.41		
1589	" "	L. G. B. Cannon, Burlington.......	4.42				13.88		
1574	" "	Nathan Way, West Burke.........	2.99				26.56		
1575	CresentGro'ndB'n	" " " "	3.04				15.75		
		Phosphatic.							
1564	Acid Phosphate..	Great Eastern Fert. Co., Rutland		13.52	2.32	0.22	16.06	15.84	
1581	" " ..	C. W. Webster, East Roxbury....		7.61	4.04	3.04	14.69	11.65	
1610	NaturalPlantFood	H. A. Bixby, Burlington..........	0.18			9.48	19.15	9.67	0.18
1614	Grn'dSo.Car.Rock	Geo. Cassie, Barre..................					25.18		
		Potassic.							
1543	Muriate of Potash	Great Eastern Fert. Co., Rutland							49.17
1573	" "	Nathan Way, West Burke.........							49.50
1580	" "	C. W. Webster, East Roxbury....							49.72

Station Nos. 1599–1600–1608–1609. The low grade of these goods is due to their being somewhat wet and to incomplete extraction of fat.

Station No. 1610. This material is probably either Pamunkey Phosphate, a soft marl-like material mined in Virginia, or a Florida soft phosphate. It contains practically nothing but phosphoric acid. Although yielding about one-half of its phosphatic contents to the chemist's solvents as "available," it is advised to use sparingly at first as its availability to plant growth is not yet definately settled.

ANALYSES OF ASHES.

Station Number.	SOURCE.	RECEIVED FROM.	Soluble Potash.	Insoluble Potash.	Total Potash.	Total Phosphoric Acid.	Insoluble Matter.	Lime.
1562		C. F. Tillotson, Morrisville. ..	1.57	2.93	4.50	2.08	30.00	
1570	Tannery..	Albert Sargent, Brookfield....	2.69	0.97	3.66	3.56		
1571	Vermont .	" " "	7.07	2.66	9.73	4.40		
1572	Canada ..	W. H. Hutchinson, Braintree	2.69	2.78	5.47	2.79		
1576	Lime Kiln	W. B. Fonda, St. Albans... .	1.38	0.84	2.22	0.89		
1582	Canada ..	L. G. B. Cannon, Burlington.	3.58	2.51	6.09	1.59		30.52
1584	"	R. Millen, Westminster West.	2.70	1.20	3.99	3.19		
1585	"	L. G. B. Cannon, Burlington.	5.17	1.52	6.69	1.73		31.36
1586	Unleach'd	Ida Mann, Randolph	4.58	1.57	6.17	1.76		
1587	Leached..	' "	1.21	0.82	2.02	1.49		
1588		G. F. Tanner, Springfield	3.36	1.89	5.25	1.13		
1597		C. M. Stebbins, Wolcott......	6.05	2.59	8.64	2.82		
1513	Lime Kiln	Geo. Cassie, Barre....	3.71	1.66	5.37	1.14	8.89	39.87

Thirteen samples of ashes varied from 1.21 to 7.07 per cent. soluble potash and from 0.89 to 4.40 per cent. total phosphoric acid. Disregarding the effect, chemical or mechanical, of other ingredients, and taking into account only the three ingredients stated, soluble and insoluble potash and total phosphoric acid, the best ashes were nearly five times as good as the poorest. The price of this class of goods is not always in accordance with quality. It is best to buy on Experiment Station analysis. Some dealers sell subject to discount in case Station analysis show deficiency.

ANALYSES OF MUCK.

RECEIVED FROM.	ORIGINAL SUBSTANCE.				DRY MATTER.		
	Moisture.	Ash.	Organic and Volatile Matter.	Nitrogen.	Ash.	Organic and Volatile Matter.	Nitrogen.
C. M. Densmore, Jamaica	89.57	0.36	10.07	0.19	3.45	96.55	1.82
" " "	84.33	0.35	15.32	0.22	2.23	97.77	1.40
E. C. Orvis, Manchester	39.20	26.14	34.66	1.22	42.97	57.03	2.00
" " "	65.20	24.97	9.83	0.37	71.76	28.24	1.07
" " "	83.87	2.85	13.28	0.51	17.70	82.30	3.03
A. B. Stoddard, West Burke	79.43	4.40	16.17	0.56	21.39	78.61	2.74
John Spooner, Enosburgh	83.08	1.78	15.14	0.42	10.52	89.48	2.52
M. R. Robbins, Brattleboro	33.85	16.30	49.85	1.33	24.64	75.36	2.01
C. I. Smith, McIndoes Falls	48.56	41.46	9.98	0.41	80.06	19.94	0.80
" " "	71.48	10.09	18.43	0.62	35.39	64.61	2.16
" " "	48.10	38.89	13.01	0.49	74.94	25.06	0.94
C. M. Stebbins, Wolcot	77.01	15.59	7.41	0.24	67.80	32.20	1.04
M. F. Sullivan, St. Albans	63.50	1.99	34.51	0.79	5.44	94.56	2.16
C M. Scarff, Burlington	29.51	18.52	51.97	1.46	26.29	73.71	2.07

Fourteen samples of muck varied from 0.80 to 3.03 per cent. nitrogen in dry matter. Those containing small amounts of nitrogen were usually full of sand and earth, as shown by high ash percentages.

ANALYSES OF "COMPLETE" FERTILIZERS.

Station Number.	MATERIAL.	RECEIVED FROM.	Nitrogen.	PHOSPHORIC ACID.					
				Soluble.	Reverted.	Insoluble.	Total.	Available.	
1565	" Light"	Loudeville Bros., Williston	1 58	3.55		8.65	12.20		2.26
1566	" Dark"	" " "	1.37	7.84		2.95	10.79		2 39
1546			1.48	6.30		3.36	9.66		2.43
1591	Lister's Success	R. L. Stickle, Shaftsbury	1.74	6.86	1.24	3.04	11.14	8.10	2.40
1605	Bowker's Flower Food	Rutland Fire Clay Co Rutland	6.65	9.79	1.22	0.94	11.95	11.01	3.67

Station Nos. 1565-1566. The parties sending these samples claimed them to be fairly representative of goods sold them as one and the same thing and under one brand. One was of a light and the other of a dark color. Analyses showed similarity in nitrogen and potash percentage but considerable difference in total phosphoric acid. No. 1546 is the analysis of the officially taken sample from the dealer's stock from which it is claimed that the goods in question were bought.

ANALYSES OF MISCELLANEOUS FERTILIZING MATERIAL.

Station Number.	MATERIAL.	RECEIVED FROM.	Nitrogen.	Total Phosphoric Acid.	
1567	Home-Made Fertilizer	E. H. Hallett, St. Johnsbury Ctr.	0.32	0.46	0.00
1568	" "	" " " "	0.23	0.39	0.00
1569	" "	" " " "	0.45	0.39	0.00
1598	Refuse Meat Cake	M. A. Nott, Burlington..........	6.30	1.54	- --
1604	Rock................	J. T. Whitlock, Brandon	- --	0.14	0.34
1407	"Ameola"............	Geo. Cassie, Barre...............	2.14	1.41	0.28

Station Nos. 1567–1568–1569. These goods were made from fresh meat, bones, fish scraps and sand, and are considerably less valuable weight for weight than barn-yard manure.

Station No. 1604. This material was claimed to have been found beneficial as a fertilizer. The same amount of phosphoric acid and potash as is present in a ton of this material may be bought in the best forms for 46 cents

Station No. 1607. It is claimed that "Ameola" is a natural product dredged from the bottom of a deep lake in Southern Florida. The same amounts of plant food in the best forms may be bought at prices lower than those quoted with this sample to the party sending it to the Station

ANALYSES OF DRINKING WATERS.

Forty-one samples of drinking water have been analyzed during the past year, 25 being from springs, 8 from wells, 6 from driven wells, and 2 from brooks. In a few cases second samples from the same supply were sent because of contamination from careless or imperfect sampling in the first instance. Discarding samples known to misrepresent the supplies, and excluding Station No. 2104, a mineral water, marked impure because of its powerful cathartic action, we find that of 23 spring waters, 3 were impure and 5 slightly suspicious; of 8 shallow well waters, 6 were impure; of 4 driven well waters, 1 was impure and 1 suspicious; and that 2 brook waters analyzed were of medium purity.

Analyses of 60 samples in 1893 and 36 in 1894, together with those given above, afford the following table:

PER CENT. OF DRINKING WATER SAMPLES FOUND IMPURE OR SUSPICIOUS.

YEAR.	SPRING WATER.	WELL WATER.	POND, ETC., WATER.
1893	12	53	71
1894	0	43	66
1895	35	67	0

In sending samples of drinking water to the station for analysis great care should be taken that the package and stopper be scrupulously clean and that the former be rinsed out several times before filling, rinsing to be done with water from the same source as is sent. A new, clean, unused maple syrup can makes a good package. A gallon is needed for analysis, which should be sent by express, prepaid, to Experiment Station, Burlington, Vt., with full statement regarding nature of water, reasons for suspicion, nature of the surroundings, etc. The Station cannot undertake the analysis of mineral waters.

The results of water analysis are best interpreted in connection with a survey of the surroundings of the supply. Chemical data which would pass a sample from one source would condemn another less favorably situated. Generally speaking, however, inland waters are considered unsafe for use if they contain more than 40 grains per gallon of total solids, 3 grains per gallon of chlorin, or more than 0.05 parts per million of free ammonia, or 0.15 parts per million of albuminoid ammonia. Samples in the following table marked * were considered impure; those marked ‡ were held to be somewhat suspicious.

Station Number.		Source of Sample.	PARTS PER MILLION.		GRAINS PER GALLON.			
			Free Ammonia.	Albuminoid Ammonia.	Chlorin.	Total Solids.	Fixed Solids.	Volatile Solids.
2079	SPRING WATER.	H. W. Hyde, Sudbury	0.01	0.065	0.2	13.5	11.1	2.4
2083		C. L. Woodbury, Burlington	0.02	0.10	Too	small	quan	tity.
*2084		A. Sykes, Hinesburgh	0.05	0.11	0.7	12.1	5.3	6.8
2085		J. H. Bates, Proctorsville	0.005	0.05	0.2	2.4	1.4	1.0
*2088		L. W. Knapp, Middlesex	0.36	0.14	0.3	8.1	6.9	1.2
2093		Dr. W. D. Huntington, Rochester	0.025	0.07	0.2	2.2	1.8	0.4
†2094		A. E. Jones, Burlington	0.01	0.07	0.8	16.2	8.1	8.1
*2095		G. O. Henry, Springfield	0.115	0.28	0.75	11.9	10.5	1.4
2096		A. E. Jones, Burlington	0.00	0.05	0.6	10.8	8.8	2.1
2097		M. W. Chandler, No. Springfield	0.03	0.105	0.4	5.6	3.5	2.1
‡2098		" "	0.05	0.05	0.35	3.9	2.5	1.4
‡2099		" "	0.06	0.045	0.35	4.2	3.1	1.1
2100		" "	0.00	0.045	0.3	3.5	2.7	0.8
2102		E. P. Hatch, Burlington	0.02	0.065	0.2	2.5	1.6	0.9
*2104		Dr. C. M. Peck, Brandon	0.01	0.13	0.3	434.1	360.4	73.7
2105		Dr. C. M. Scribner, Barre	0.03	0.075	0.1	10.3	8.4	1.9
2106		P. MacDonough, Hinesburgh	0.035	0.04	0.1	8.6	6.9	1.7
2108		Fred Paradise, Stamford	0.02	0.06	0.1	1.3	0.9	0.4
‡2109		Dr. C. M. Scribner, Barre	0.06	0.085	0.4	15.6	13.3	2.3
‡2110		" "	0.06	0.05	0.4	13.9	10.9	3.0
2111		" "	0.04	0.04	0.2	9.5	7.4	2.1
‡2112		" "	0.05	0.06	0.2	7.7	6.5	0.8
2117		F. S. MacKenzie, Woodstock	0.005	0.065	0.5	9.6	7.7	1.9
2118		W. H. H. Slack, Springfield	0.00	0.08	0.85	17.5	13.3	4.2
2119		A. R. Hunter, Bethel	0.00	0.07	0.7	8.8	6.8	2.0
2082	WELL WATER.	O. G. Buck, Johnson	0.00	0.06	0.2	4.6	2.8	1.8
2086		A. B. Stoddard, West Burke	0.03	0.03	0.4	10.7	8.6	2.1
*2087		M. M. Francis, Burlington	0.15	0.13	0.5	21.7	17.2	4.5
*2091		Dr. C. W. Peck, Brandon	0.025	0.225	2.45	25.6	21.4	4.2
*2092		" "	0.01	0.15	2.1	17.1	14.6	2.5
*2113		M. M. Francis, Burlington	0.05	0.145	0.4	20.7	17.9	2.8
*2114		F. M. Wedgwood, Essex Junction	1.06	0.07	1.6	12.3	7.8	4.5
*2115		Dr. H. A. Crandall, Burlington	0.055	0.145	0.8	13.5	9.1	4.4
2081	DRIVEN WELL WATER.	F. H. Crandall, Burlington	0.01	0.01	0.2	15.1	13.3	1.8
‡2089		C. E. Miner, "	0.07	0.045	0.5	29.6	24.2	5.4
‡2090		" "	0.07	0.08	0.4	......	......	......
*2107		H. J. Carpenter, Charlotte	0.155	0.00	0.4	21.7	17.5	4.2
2116		C. B. Kent, Dorset	0.005	0.06	0.55	19.1	16.5	2.6
*2121		Dr. A. H. Byington, Charlotte	0.70	0.16	0.4	20.3	17.1	3.2
2080	BROOK WATER	F. H. Crandall, Burlington	0.01	0.08	0.3	2.3	1.1	1.2
2103		W. H. DuBois, Randolph	0.00	0.10	0.2	12.2	12.0	0.2

* Impure.

† Probably some non-nitrogenous organic matter in this sample caused the high volatile solids. Station No. 2096, from the same source a few days later, did not show this.

‡ Free ammonia a little high, but owing to nature of surroundings cause for suspicion rather than certain impurity should be attached to analysis.

THE CONSUMPTION OF COMMERCIAL FERTILIZERS IN VERMONT.

The use of commercial fertilizers by the farmers of the State has rapidly increased within the past eight or ten years until it has reached large proportions. This growth may be seen both in the multiplication of brands and by the increased sales. When the fertilizer law first went into operation in the spring of 1883, twenty brands, the output of ten companies, were sold and analyzed. At least one hundred and twelve brands were sold and one hundred and ten analyzed in 1896, seventeen firms doing business in the State.

So far as is known the only canvass for the purpose of ascertaining the gross tonnage of commercial fertilizers used in Vermont, was made by this Station in 1888, the results being published in Bulletin 15. It was confessedly incomplete, and showed a probable use of 4,194 tons. Attempts were made in 1894 to get shipment figures from the various manufacturers, but several for business reasons were unwilling to furnish them, and the project was abandoned. Better success resulted, however, during the current year, the data being obtained from the railroad stations at which the goods were unloaded.

The thanks of the Station are due Col. E. A. Chittenden, General Freight Agent of the Central Vermont Railroad, and to the individual local station agents of the Boston and Maine, Montpelier and Wells River, Bennington and Rutland, Delaware and Hudson, Canadian Pacific, Grand Trunk, Woodstock, and Hoosac Tunnel and Wilmington Railroads for their courtesy in furnishing information.

Returns were received from 180 of 189 stations, and the estimates may be made for the few missing with a fair degree of accuracy.

It does not follow that all the goods brought into the State were sold or used, although there is no reason for thinking that more was carried over one winter than another. Neither does the data at hand enable us to determine what, if any, reshipments took place within State lines, nor what proportion of the goods unloaded in Vermont were used in adjoining states. The location of railroad lines, however, is such as to make it probable that the interchange between Massachusetts and New York on the one hand and Vermont on the other may be considered equal. A considerable amount, however, unloaded at stations between South Vernon and Bellows Falls, and between Windsor and Barnet on the Boston and Maine lines paralleling the Connecticut River, is used in New Hampshire. While it is more or less guess work to try and estimate this, it is probable that it amounts to from 500 to 800 tons.

The total returns, including estimates for the nine points not reporting, show that 13,623 tons were unloaded. Making due allowance for New Hampshire's use of goods unloaded in Vermont, it is probably safe to say that *the present yearly fertilizer trade in Vermont approximates* 13,000 *tons*. The average selling prices for 1895 and 1896 were identical, $30.90 per ton. This would make a total of $401,700 paid yearly in the State for commercial fertilizers.

This rapid increase in the use of this class of goods is evidence that on the whole they have been useful. Competition and inspection have served as a rule to maintain quality, and of late years the general run of goods have been what they were represented to be. The prices now placed on the average goods are less than in former years, but as has been previously pointed out, they have not fallen in proportion to the drop in crude stock.

It is safe to say that if in place of buying in small lots on time the system of co-operative purchase and home mixing were in vogue, the same amount of plant food of equally good quality might be laid down at Vermont depots at less than four-fifths of the present outlay.

COMMERCIAL FEEDS.

During the past year a study has been made of the character of the grain feeds offered to the farmers of the State. The study was designed to cover:

1. Kinds of feed used.
2. Chemical composition of the various feeds.
3. Cost of the nutrients in the various feeds.
4. Fertilizing value of various feeds.
5. Economical purchase.

I. KINDS OF FEED USED.

A thorough canvass made by means of letters addressed to the millers throughout the State showed, as might be expected, that corn meal, wheat bran and middlings, oats, corn and oats, (provenders) linseed, cottonseed and certain gluten meals and feeds were most commonly used. A few reports showed small sales of ground wheat, buckwheat, buckwheat and rye brans and middlings, rye meal, rye feed, barley, oat feed and cottonseed bran.

The agents of the Station sent out to sample commercial fertilizers in the spring were instructed to obtain feed samples as found on the market. In all one hundred and twelve samples, representing twenty-two different feeds, were taken. Adding to these such feeds as have been sent in this year by the citizens of the State, some analyses in connection with feeding tests of the winter of 1895-96, and several received from L. B. and F. Howe of Jericho, we have the analyses of one hundred and forty-one samples, representing thirty-four different feeds, as follows:

Animal meal	1	India wheat hulls	1
Atlas gluten meal	3	India wheat meal	1
Buckwheat flour	1	Linseed meal, new process	7
Corn meal	18	" " old process	2
Corn and oats	5	Maize food, Chicago	1
Corn oil cake	2	Mixed feed	15
Cottonseed bran	2	Oats, ground	2
Cottonseed meal	11	Oat middlings	1
Dairy feed	1	Rye	1
Flour, Red Dog	1	Rye meal	1
Graham flour	1	Rye and India meal	1
Gluten meal, Chicago	8	Wheat bran	29
" " Davenport	1	Wheat food	4
" " Golden	1	Wheat meal	2
" " King	1	Wheat middlings	11
Gluten feed, Buffalo	3	Gluten feed, Cream	1
Hominy food	1	Horse food	1

2. CHEMICAL COMPOSITION.

At first sight it may seem that the repeated analyses of commercial food stuffs from year to year were unnecessary, that the average of the many analyses now on hand would serve the purpose. Yet as a matter of fact they are useful as a means of studying the variation in feeding stuffs of the same name and class; they serve to show the value, or the reverse, of new products, or those which are altered by modifications in the method of manufacture; they go to swell the data from which true averages are made; and, finally, are, in connection with the microscope, sometimes helpful in detecting adulteration.

The money paid out for feeding stuffs is far greater than that paid for commercial fertilizers, which are yearly subjected to rigid inspection. The relative food values of the different feeds having approximately equal money values may frequently be widely apart, a fact which cannot be too often reiterated.

WHEAT BRAN.

	Name. Location.	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.	Selling Price.
674	Wheat Bran, Johnson..........	10.70	6.32	17.00	7.38	53.44	5.16	2.72	.....	.....	.....
675	" " East Clarendon..	10.30	5.34	18.16	7.50	53 02	5.68	2.91	.....	.....	.....
676	" " South Royalton..	12,29	7.01	15.75	7.63	51.89	5.43	2.52	.....	.....	... .
677	" " Plainfield........	9-98	6.63	17 07	8.30	52 39	5.63	2 74	.....	....	.....
678	" " Brandon..........	9.86	6.42	16.63	6.61	54.85	5.63	2.67	.....	.....	.....
3638	" " Underhill........	11 26	5.28	17.72	10.03	50.91	4.80	2.84	... .	1.37	.....
3625	" " Cambridge.......	8 82	2.83	5.72	24 60	58	03	0.91	.....	.....	$
4011	" " Lyndonville.....	10.55	4.72	17.29	6.48	56.16	4.80	2.77	0.68	1.20	16.
3959	" " Northfield........	10.55	5.29	16.85	8.48	53.85	4.98	2.70	1.03	1.54	16.
3966	" " Woodstock.......	9.33	5.00	21.67	9.08	49.32	5.60	3 47	1.07	1.45	16.
3973	" " Bradford........	10.01	6.07	16.19	9.95	52.45	5 33	2.59	0.65	1.31	.....
3978	" " Vergennes........	10.21	5 64	15.10	10.50	53.36	5.19	2.42	0.78	1.27	16.
3980	" " Castleton........	9.80	4.85	18.16	7.03	56.51	3.65	2.91	1.07	0.94	. ...
4035	Superior Bran, Johnson........	11 10	6.66	16 50	7.73	58	01	2.65	.....	1.53	.....
3993	" " St. Johnsbury..	15.13	5.58	14.66	9 15	49.58	5.90	2.35	0 69	1.29	15.
3967	" " Thetford...... .	10.01	5.68	15.53	9.43	53 77	5.58	2.49	1.02	1.30	16.
4030	Spring Bran, Essex Junction..	9.62	6.38	15.97	11.18	51 25	5.60	2.56	1.09	1.76	15.
3999	" " West Concord....	9.60	5.14	18 60	9.58	50.88	6 20	2 98	0.75	1.29	15.50
4018	" " Newport.	9.40	5.87	17.07	9.88	53 18	4.60	2 73	1.07	1.37	15.
4017	Winter Bran, Lyndonville......	10.09	7.16	15.75	8.65	53.87	4.48	2.52	0.81	1.25	17.
4029	" " Essex Junction..	10.17	5.66	17.29	7.43	54.35	5.10	2.77	0.82	1.53	16.
3639	Pillsbury's Bran, Underhill....	10.62	6.07	18.16	7.58	51.84	5.73	2.91	.....	1.58	.....
4033	" " Essex Junc..	9.95	6.24	17.50	10.30	50.28	5.73	2.80	0.86	1.66	16.
4023	" " St. Albans...	9.29	5.35	18.16	9.05	52.72	5 43	2 91	0.81	1.39	16.
3990	Feed Bran, Johnson......	10.25	4.70	15.53	6 98	58.26	4 28	2.49	0 97	1.08	15 50
3991	Clear Bran, Johnson............	9.75	5.76	16 63	7.65	55.34	4.87	2.66	0.70	1.16	16.
4001	Bodie Bill Bran, Barnet........	9.65	4.99	14.88	11.93	54.17	4.38	2.38	0.91	1.24	17.
4010	Mich. White Br. McIndoes Falls	9.59	5.45	17.07	10.10	53.16	4.63	2.73	0 67	1.16	18.
4015	V. C. W. Co.'s Bran, Lyndonv'e	9.81	6.00	15.97	8.38	54.91	4.93	2.56	0.99	1.22	15.
	Average*..................	10.32	5.76	16.87	8.70	53.18	5.16	2.70	0.87	1.37	. ...

WHEAT MIDDLINGS.

682	Wheat Middlings, Plainfield........	9.90	4.49	17.18	6.64	55.64	6.15	2.75	....	.. .	$
4021	" " Richford....... ..	10.30	3.69	18 60	6.53	56.07	4.81	2.98	0 63	1.02	18.
4034	" " Essex Junction..	10.67	3.80	19.69	5.70	54.99	5.15	3.15	0.63	1.09	17.
3986	" " Wilmington.......	10.36	3.53	19.04	5.70	56.22	5.15	3.05	1.00	0.97	.....
3997	Fine Middlings, West Concord......	10.33	3.28	18.16	5.08	58.17	4.98	2.91	0.59	0.89	18.
4013	" " Lyndonville........	10.63	2.79	18.60	2.83	61.27	3.88	2.98	1.03	0.77	19.50
4005	Spring Middlings, Barnet....	10.52	3.18	17.94	3.58	59.33	5.45	2.87	0.88	0 87	17.
4026	" " St. Albans........	10.87	3.55	19.48	5.15	56.00	4.95	3.12	0.86	0.91	18.
3969	Superior Flour Middlings, Thetford	10.01	3.97	17.07	4.68	58.52	5.75	2.73	1.00	0.35	17.25
4007	Dairy Middlings, McIndoes Falls...	10.99	2.37	17.72	1.48	63.11	4.33	2 84	0.79	0.68	18.
4024	" " " " ...	11.40	2.21	18.60	1.50	62.34	3.95	2.98	0.78	0.56	18.
	Average..........................	10.54	3.35	18.37	4.44	58 34	4.96	2.92	0.82	0.81	.....

WHEAT FOOD AND MEAL.

	Name. Location.	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid	Potash.	Selling Price.
3637	Wheat Food, Underhill...	13.16	2.03	12.92	7.62	61.44	2.83	2.07	0.74	0.51	....
3648	" " South Ryegate..........	11.38	5.21	18.93	6.70	53.16	4.62	3.03	1.57	1.40	....
3649	" " Rutland..	9.19	5.45	17.88	8.69	54.56	4 28	2.86	1.47	1.60	....
681	Mixed Wheat Food, Wolcott..........	9 05	6.16	16.85	6.58	55.56	5.80	2 70	....	....	....
3635	Wheat Meal, Underhill................	11.64	1.49	12.92	1.45	70.98	1 52	2.07	0.22	0.29	....
3636	Wheat Cream Meal, Underhill..	12.09	2.17	13.79	2.30	67.52	2 13	2.21	0.64	0.47	....
											....
	Average Nos. 3648-49 and 681.....	9.87	5.61	17.87	7.32	54.43	4.90	2.86	1.52	1.50	....
											....
	Average Underhill Samples....	12.30	1.90	13.21	3.79	66.65	2.16	2.11	0.53	0.42	....

* Exclusive of Station Number 3625.

CORN MEAL.

691	Corn Meal, Wolcott..................	10.95	1.60	10.29	2.28	70.63	4.25	1.65	....	....	.....
692	" " Cambridge................	11.33	1.57	9.41	1,85	71.64	4.20	1 51	..,.	....	.....
693	" " South Royalton..........	10 75	1.50	10.43	2.28	70.81	4.23	1.67	....	....	.....
694	" " East Hardwick...... ..	12.96	1.60	9.08	2.17	70.00	4.19	1.46	....	....	.....
695	" " Bethel.....................	10.96	1.52	9.41	1 98	71.85	4.28	1 50	....	....	.....
696	" " Vergennes...............	11.76	1.71	9.52	2.09	70.86	4.06	1.53	....	....	.....
697	" " East Clarendon.....	14.44	1.31	9.08	1.85	69.84	3.48	1.46	....	....	.....
698	" " Middlebury..............	11.66	1.68	9.85	1.58	71.18	4.05	1.58	....	....	.....
699	" " Waterbury..............	11.37	1.42	9.41	2.38	70.79	4.63	1.51	....	....	$
4014	" " Lyndonville...............	11 24	1.29	10.73	2.10	71.34	3.30	1.72	0.58	0.47	16.50
4027	" " St. Albans................	11.26	1.45	9.85	2.85	70.29	4.30	1.58	0.56	0.42	17.
3970	" " Thetford	10.65	0.99	9.85	1.45	73.58	3.48	1.58	0.55	....	16.
3975	" " Vergennes...............	10.57	1 36	10.51	2.15	71.65	3.76	1.68	0.64	0.38	17.
3979	" " Castleton.	10.53	1.26	10 51	2.15	71.40	4.15	1.68	0.60	0.29	.....
3981	" " Fair Haven.....	10.61	1.41	10.07	2.05	71.68	4.18	1.61	0.56	0.39	.....
3630	" " Underhill	11.92	1.55	10.94	2.05	69.64	3.90	1.75	0 57	0.15	.....
3992	Clear Corn Meal, Johnson............	10.19	1.22	9.44	1 35	74.05	3.75	1.51	0.52	0.87	16.
3631	Granulated Corn Meal, Underhill...	12.43	0.85	8.97	0.65	75.12	1.98	1.44	0.31	0.25	.....
.... 815	Average, exclusive of No. 3631	11.37	1.44	9.90	2.04	71.24	4.01	1.59	0.55	0.40	.....

CORN AND OATS.

3974	Corn and Oats, Vergennes.........	10.06	2.31	11.82	5.13	67.10	3.58	1.89	0.68	0.41	$ 18.
3988	" " Johnson............	10.40	1.59	10.29	4.25	68.84	4.63	1 65	0.51	0.46	17.
3989	" " Johnson....	10 04	3.41	8.10	10.68	64 09	3 68	1 30	0.55	0 50	14.50
4008	" " McIndoes Falls....	9.20	3.54	10.07	10.93	63 33	2.93	1.61	0 55	0.62	16.
4032	" " Essex Junction....	9.65	2 35	11.38	5.18	67 01	4.43	1.82	0 63	0 54	18·
	Average......................	9.87	2.64	10.33	7.23	66.08	3.85	1.65	0.58	0.51	.....

MIXED FEEDS.

	Name. Location.	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid	Potash.	Selling Price.
685	Mixed Feed, Bethel.	10.14	2 53	9.63	3.78	70.02	3 90	1.55	....	....	.....
3708	" " St. Johnsbury.........	9.19	3.45	8.97	12.99	65	40	1.44	....	....	$
3960	" " Northfield.............	10.02	6.60	15.53	7.58	56.21	4.06	2.49	0.83	1.17	16.
3982	" " Fair Haven.	9.78	1.82	10.94	4.90	68.83	3.73	1.75	0.57	0.38	.....
3985	" " Wilmington.	10.06	3 78	14.01	13.85	54.82	3.48	2.24	0.95	0.87	.....
4016	" " Lyndonville..........	9.69	3.73	9.44	11.18	63 06	2 90	1.51	0.46	0 60	17.
3995	Superior Mixed Feed, St Johnsb'y	9.10	3.90	15.10	8.20	58.00	5.70	2.42	0.72	1.18	16.
3968	" " " Thetford ...	9.86	5.46	17.72	6.85	55.31	4.80	2.84	0.83	0.93	17.25
3996	Boston Mixed Feed, St. Johnsbury	9.80	4.70	15.53	7.10	57.37	5 50	2.49	0.78	1.29	16.50
3998	" " " West Concord	11.20	5.01	15.97	7.13	55.44	5.25	2.56	0.68	1.11	17.
4010	Thompson's Mixed Feed, Richford	10.34	5.50	19 04	7.23	53.61	4.28	3.05	0.78	1.37	19.
4028	Mill's Winter " " St. Albans	9.79	5.82	17.94	7.25	53.72	5.48	2.87	1.00	1.31	17.
4031	Mixed Feed No 2, Essex Junction..	10.63	2.52	12.50	4.58	65.79	3.98	2.00	0.82	0.60	17.
3977	Fine Mixed Feed, Vergennes.	10.21	4.81	17.29	7.85	54.56	5.28	2 77	0.83	1.03	17.
679	Western Provender, Waterbury ...	7.16	5 78	13.57	8.60	57 79	7.10	2.18	....	....	.....
	Average.........................	9.79	4.36	14.21	7.94	59.10	4 60	2.27	0.77	0.99	.....

COTTON SEED MEAL.

700	Cotton Seed Meal, Cambridge......	8.44	8.14	41.46	4.68	24 48	12 80	6.64	....	....	.....
701	" " " Middlebury.....	6.96	8.49	44.20	3.60	24 91	11.84	7.07	....	....	.....
702	" " " Waterbury......	7.10	8.54	43.99	5.20	25.24	9 93	7.04	....	....	.....
703	" " " Plainfield.......	8.24	6.99	44.31	5.10	27.04	8.32	7.09	....	....	.....
704	" " " Cabot..	8.78	7.84	42.34	4.79	26 21	10.04	6 78	....	....	....
705	" " " Bethel...........	7.07	7.46	41.36	5.95	27 34	10.82	6.62	....	....	$
3964	" " " Woodstock......	7.33	7.44	44.88	4.45	24.94	10 96	7.18	0.99	1.25	25.
3972	" " " Thetford........	7.31	7.15	44.44	5.13	26.04	9 93	7.11	1.00	1.25	23.
4006	" " " McIndoes Falls.	7.85	7.02	40.75	6.98	27.55	9.85	6 52	0.84	1.91	23.50
4012	" " " Lyndonville...	7.33	7.20	39.81	6.29	29.17	10.20	6.37	0.91	1.14	23.
4022	" " " St. Albans.......	7.60	7.18	41 81	6.34	26.59	10.48	6.69	0 75	1.81	22
	Average.........................	7.64	7.59	42.67	5.32	26.31	10.47	6.83	0.90	1.47	.....

LINSEED MEAL.

	Linseed Meal, old process,										
4009	" " McIndoes Falls	9.30	4.94	37 00	7.60	34.18	6 98	5.92	0.75	1 27	$
3965	" " Woodstock.....	7.71	5.78	35 00	8 45	35.93	7.13	5.60	0.58	1.20	24.
	Linseed Meal, new process,										
3642	" " Underhill.......	9.00	5.70	39.38	5.90	35 57	4 45	6 30	1.92	1.02	.....
3961	" " Northfield......	8.15	5.49	44.00	7.73	32.13	2.50	7 04	0 58	0 18	22.
690	" " Middlebury.. ..	8.45	5.62	40.81	8.55	34.08	2 49	6 53	....	....	. ...
4002	" " Barnet.........	9.35	4.86	36.31	10.23	35 82	3 43	5.81	0.74	1 06	20.
687	" " Hardwick..... .	9 61	5.78	36.76	10.09	33.88	3 97	5.89	....	....	.....
688	" " Vergennes......	8 27	6.18	36.43	9.04	36 93	3.15	5.84	....	....	.....
689	" " Cabot............	10.30	5 78	38 65	8.89	36 16	2.22	5.87	....	. ..	. ...
	Average old process..........	8.50	5 36	36.00	8 03	35 05	7.06	5 76	0.58	1 24	....
	Average new process..	9.02	5.63	38.62	8.62	34 94	3.17	6.18	. ..	....	.....

GLUTEN MEALS.

	Name. Location.	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid	Potash.	Selling Price.
668	Chicago Gluten Meal, Underhill...	8.91	1.49	38.40	2.78	40 92	7.50	6.15	....	....	.....
669	" " " Brandon.. .-	8.01	1.61	41.24	2.98	37.41	8.75	6.60	....	.. .	.....
670	" " " Plainfield...	10.19	1.28	29.20	1.68	53.61	5.04	4.68	....	....	$
3976	" " " Vergennes .	7.31	2.31	37.00	2.53	44.00	6.85	6.00	0 59	0.09	25.
3962	" " " Northfield. .	7.74	2.12	38.06	3 25	40.51	8.32	6.09	0.64	0.44	22.
3971	" " " Thetford....	8.04	0.60	40.50	2.83	40.78	7.25	6.48	0.65	0 12	22.40
4025	" " " St. Albans..	7.66	1.85	39.62	3.25	37.97	9.65	6.34	0.41	0.14	21.
4019	" " " Richford....	8.46	1.52	39.62	2.70	41.30	6.40	6.34	0.54	0.08	20.
3627	Atlas Gluten Meal, Burlington ...	5.70	2 63	37.93	10.79	27.69	15.26	6.07	0.63	0.15	.....
3643	" " " "	8.27	2.88	35.31	11.48	28.16	13.90	5.65	0.60	0.11	.....
3628	Davenport Gluten Meal, Windsor.	4.55	1.50	23.71	7.88	47.83	14.53	3.79	0.19	0.06	21.50
4003	Golden Gluten Meal, Barnet	7.41	0.89	31.75	8.30	41.57	10.08	5.08	0 49	0.27	.....
3960	King Gluten Meal, Burlington.....	7.92	3.88	41.44	1.52	43	24	6.63	0.97	0.03	.....
	Average......................	7.70	1 89	36.44	4.77	40.98	9.50	5.84	0.57	0.15	.....

GLUTEN FEEDS.

3641	**Buffalo Gluten Meal, Underhill.......**	**8 17**	**2.25**	**24.07**	**9.58**	**44.65**	**11.28**	**3.85**	**0.92**	**0 35**	**...**
671	**" " " Johnson........**	**8.30**	**1.13**	**23.13**	**7.48**	**46.59**	**13 37**	**3.70**	**. ..**	**....**	**...**
672	**" " " Hardwick ......**	**8.15**	**1.10**	**21 38**	**7.77**	**47.32**	**14 28**	**3.42**	**....**	**....**	**$**
4004	**Cream Gluten Feed, Barnet............**	**7.75**	**1.08**	**27.00**	**8.15**	**48 02**	**8.00**	**4.32**	**0.46**	**0 35**	**19.**
	Average...........................	**8.09**	**1.39**	**23.89**	**8.25**	**46.64**	**11.74**	**3.82**	**0.69**	**0.35**	**...**

MISCELLANEOUS FEEDS.

											$
3963	Animal Meal........................	4.29	21.40	29.13	3.00	29.13	13.05	4.66	7.41	1.82	45
3629	Buckwheat Flour, Underhill.......	13.58	0.91	7.21	0.40	77.30	0.60	1.16	0.26	0.23	..
3645	Corn Oil Cake, Burlington	9.54	3.66	22.66	7.78	40.83	15.53	3.63	1.43	0.26	..
3644	Cotton Seed Bran, Burlington......	11.56	3.32	12.38	26.92	41.32	4.50	1.98	0.75	1.26	17
3640	Dairy Feed, Underhill..............	8.96	5.86	28.67	7.65	40.16	8.70	4.59	1.77	1.04	..
680	Flour, Red Dog, Underhill..........	9.02	3.75	22.22	1.85	57.46	5.70	3.56	....	....	..
3632	Graham Flour, Underhill...........	12.36	1.76	12.26	1.33	70.64	1.65	1.96	0.64	0.40	..
4037	Hominy Food, Cabot................	7.98	3.52	12.78	4.88	70	84	2.05	....	0.94	..
683	Horse Feed, Middlebury............	10.49	3.24	8.97	9.49	63.32	3.49	1.44	....	....	..
3626	India Wheat Hulls, West Burke....	11.95	2.15	2.71	49.13	34	06	0.44	....	....	..
4036	India Wheat Meal, Johnson.	15.12	1.93	12.90	2.70	67	30	2.07	....	0.53	..
3961	Chicago Maize Feed, Burlington...	9.60	1.40	23.52	6.75	58	37	3.37	0.49	0.07	..
3709	Ground Oats, Dorset...............	7.52	4.37	12.16	16.69	59	26	1.95	....	....	..
3994	Ground Oats, St. Johnsbury........	9.34	3.56	12.92	10.30	59.33	4.55	2.07	0.69	0.55	20
684	Oat Middlings, Cambridge..........	7.08	5.95	11.05	1.51	69.86	4.55	1.77	....	....	..
3983	Rye Feed, Fair Haven..............	11.11	2.00	11.16	1.90	72.17	1.66	1.79	0.26	0.52	..
3633	Rye Meal, Underhill................	12.50	1.74	11-60	2.14	69.[illegible]2	2.20	1.86	0.76	0.51	..
3634	Rye and India Meal, Underhill. ...	12.42	1.64	10.29	0.90	72.62	2.13	1.65	0.44	0.39	..

DISCUSSION OF THE ANALYSES.

In considering these analyses the following questions naturally arise:

1. Are the feeds they represent of standard quality?
2. What variations exist in goods of the same class?
3. What adulteration, if any, was found?

The first question can be best answered by comparing the averages of each class with the averages as given in the most complete set of American analyses now extant, those published in Bulletin No. 11, Office of Experiment Stations, by Jenkins and Winton, which may be taken as standard.

	No. of Samples.	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Ex.	Ether Ex.
Wheat Bran,							
Standard..........	88	11.9	5.8	15.4	9.0	53.9	4.0
Vermont...........	28	10.3	5.8	16.9	8.7	53.2	5.1
Wheat Middlings,							
Standard..........	32	12.1	3.3	15.6	4.6	60.4	5.0
Vermont..	11	10.5	3.4	18.4	4.4	58.3	5.0
Corn Meal,							
Standard..........	77	15.0	1.4	9.2	1.9	68.7	3.8
Vermont.........	17	11.4	1.4	9.9	2.0	71.3	4.0
Linseed Meal (old process),							
Standard..........	21	9.2	5.7	32.9	8.9	35.4	7.9
Vermont.....	2	8.5	5.4	36.0	8.0	35.0	7.1
Linseed Meal (new process),							
Standard..........	14	10.1	5.8	33.2	9.5	38.4	3.0
Vermont..........	6	9.0	5.6	38.6	8.6	34.9	3.2
Cotton Seed Meal,							
Standard..........	35	8.2	7.2	42.3	5.6	23.6	13.1
Vermont...........	11	7.6	7.6	42.7	5.3	26.3	10.5
Gluten Meals,							
Standard..........	32	8.7	1.3	33.5	1.4	44.1	10.9
Vermont...... ...	13	7.7	1.9	36.4	4.8	41.0	9.5
Gluten Feed,							
Standard..		7.8	1.1	24.0	5.3	51.2	10.6
Vermont..........	4	8.1	1 4	23.9	8.3	46.6	11.7

Wheat food and wheat meal do not appear in the standard tables, being comparatively new products, or at least newly named. "Corn and oats" and mixed feeds are of too irregular composition to admit of a safe "standard" being assigned.

Comparing the figures given above we find that the Vermont wheat bran and middlings samples contained more protein and fat than standard, the two linseed meals more protein, but that in other particulars, and the other goods in all particulars, were essentially the same as standard.

It would appear, therefore, that the average goods offered the Vermont trade are up to standard. Is this statement true, however, for all the goods? What variations exist? Are there adulterations?

The following table shows maximum, minimum and average of each of the more common goods:

	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Extract.
Wheat Bran,						
Maximum*.. ..	15.13	7.16	18.60	11.93	58.26	6.20
Minimum*	9.29	4.70	14.66	6.48	49.32	3.65
Average*.......	10.32	5.76	16.87	8.70	53.18	5.16
Wheat Middlings,						
Maximum.......	10.99	4.49	19.69	6.64	54.99	6.15
Minimum.......	9.90	2.21	17.07	1.48	63.11	3.88
Average.........	10.54	3.35	18.37	4.44	58.34	4.96
Corn Meal,						
Maximum†.....	14.44	1.71	10.94	2.85	74.05	4.63
Minimum†	10.19	0.99	9.08	1.35	69 84	3.30
Average†........	11.37	1.44	9.90	2.04	71.24	4.01
Corn and Oats,						
Maximum.......	10.40	3.54	11.82	10.93	68.84	4.63
Minimum.......	9.20	1.59	8.10	4.25	63.33	2.93
Average.........	9.87	2.64	10.33	7.23	66.08	3.85
Mixed Feed,						
Maximum.... ..	11.20	6.60	19.04	13.85	70.02	7.10
Minimum.......	7.16	1.82	8.97	3.78	53.44	2.90
Average.........	9.79	4.36	14.21	7.94	59.10	4.60
Linseed Meal,						
Maximum.......	10.30	6.18	44,00	10.23	36.93	4.45
Minimum... ...	8.15	4.86	36.31	7.73	32.13	2.22
Average.........	9 02	5,63	38.62			3.17
Cotton Seed Meal,						
Maximum.	8.78	8.54	44.44	6.98	29.17	12.80
Minimum.......	6.96	6.99	39.81	3.60	24.48	8.32
Average.........						
Gluten Meal,						
Maximum.......	10.19	3.88	41.44	11.79	53.61	15 26
Minimum......	5.70	0 60	23.71	1.52	27.69	5.04
Average.........	7.70	1.89	36.44	4.77	40.98	9.50
Gluten Feed,						
Maximum.......	8.30	2.25	27.00	9.58	48.02	14.28
Minimum... ...	7.75	1.08	21.38	7.48	44.65	8.00
Average.........	8.09	1.39	23.89	8.25	46.64	11.74

The wheat brans and middlings were fairly uniform in quality with the exception of No. 3625. Yet the extremes are not as close as might be wished. It is worthy of note that the bran containing the highest protein and fat percentage, modestly named spring bran, sold for $1.50 less per ton than the poorest sample, with a grandiloquent name, but 20 and 30 per cent. less of the two most valuable nutrients.

Corn meal, as might be expected, is very uniform in character. Being the product of simple grinding of a staple farm product, it is not open to the fluctuations due of variations in manufacturing processes.

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* Exclusive of Station No. 3625.

† Exclusive of Station No. 3631.

The most suggestive variations are those which exist in the "corn and oats" and "mixed feed" samples.

The average compositions of corn meal and of oats are

	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Ex.
Corn Meal....	15.0	1.4	9.2	1.9	68.7	3.8
Oats.........	11.0	3.0	11.8	9.5	59.7	5.0

A common mixture is half and half, which would have a composition approximating

	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Ex.
Corn and Oats,	13.0	2.2	10.5	5.7	64.2	4.4

This we find agrees reasonably well with the analyses of Station Nos. 3974, 3988, and 4032; but how shall we explain the remarkably high ash and crude fiber contents of Station Nos. 3989 and 4008, in each of which there are larger percentages of these two ingredients than normally exist in either of these two grains of which the goods are purported to be made?

Corn and oats cannot possibly be combined in any way to give such figures. In looking up the history of these two samples, they proved to be the product of two different companies engaged in oatmeal manufacture. The composition of *oat hulls* is approximately

	Water.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Ex.
Oat Hulls,	7.0	7.0	3.0	30.0	52.0	1.0

A composition very close to that found in the samples in question would be obtained by a mixture of two parts corn meal and one part each of oats and oat hulls. These goods were sold at much lower prices than the regular goods, and *if sold for what they are and on their merits* may not be bad investments.

Station Nos. 3708 and 4016 of the mixed feeds run suspiciously high in crude fiber and low in protein. Oats occasionally exceed ten per cent. in crude fiber. Cob meal, pea meal, malt sprouts, dried brewers' grains, and occasionally linseed meal, bran and middlings, exceed ten per cent. in crude fiber. It is almost inconceivable, however, that any mixed feed can be made out of legitimate materials and carry over ten per cent crude fiber, unless made of at least three-quarters of the above named materials (other than cob meal). These goods therefore may be fairly classed as suspicious. Under the microscope corn starch was found more abundant in No. 3708 than was oat starch, and oat hulls in apparent excess as compared with the amount of oat starch present. It should be noted that at the same price nearly twice as much protein and fat was bought in another sample, with somewhat less carbohydrates. The moral of this object lesson is obvious.

The only other samples calling for comment from the standpoint of adulteration are Station Nos. 3625 and 3709. No. 3609, a so-called bran, contained but a third of the protein it should have had; the crude fiber was three times the normal amount, and the ash phenomenally low. Corn cob, cotton seed hulls and the straws, are the only adulteratives in the list of fodder materials which fulfill these conditions. Under the microscope this sample showed a large amount of fibrous material looking like disintegrated straw.

No. 3709, purporting to be ground oats, was found to contain higher ash and crude fiber contents than any analysis of genuine oats on record. Yet protein was up to standard. The microscope showed oat, corn, rye and barley starches present. The sample, though somewhat suspicious, cannot surely be classed adulterated.

The following statements are explanatory of the fodder materials more or less new to the stock feeders of the State.

Wheat Food and Meal. The former does not differ essentially in chemical composition from bran. The latter is decidedly the poorest of the wheat products in feeding value.

Animal Meal. This product is usually a dried, extracted slaughter-house refuse. Sample No. 3963, however, seems to contain some vegetable matter in addition.

Corn Oil Cake. This is the expressed residue left from the treatment of the germs of the corn kernal for its oil.

Cotton Seed Bran. This material, happily sold thus far only in a small way the State, is a delusion and a snare. It is a mixture of cotton seed meal and cotton seed hulls, the latter in much the largest proportion. It is sold for about three-quarters the price of cotton seed meal and has perhaps a third of its feeding value. The result of feeding experiments with this material are given later in this volume.

Hominy Food. This is made up largely of the germ and hull of the corn kernel; resembles corn meal in its character, though usually somewhat richer.

Chicago Maize Feed. This is a glucose refuse containing germ and hull of the kernel.

Atlas Gluten Meal. This is a dried distillery refuse which is not properly a gluten meal, yet ranks with that class of goods as a highly concentrated feeding stuff.

3. COST OF NUTRIENTS IN THE VARIOUS FEEDS.

One of the most common questions asked of the Station and of the institute worker is: Which is the cheaper, bran at—— or corn meal at——? A simple means of expressing the relative money value of fodders and feeds, a "valuation" system somewhat like that used in the inspection of commercial fertilizers seems to be much desired by farmers.

It is not, however, as simple a problem as it would seem to apply proper values to the nutrients in commercial food stuffs. They are not on the market separately, but each food contains more or less of several nutrients.

Protein as such, apart from fat or carbohydrates, is not upon the market, and the sixteen dollars paid for corn meal, for instance, buys protein, fat, nitrogen-free extract and crude fiber, four nutrients for one price, and who shall say how much either one costs of itself. Moreover, the selling price and food values of fodders and feeds are not always, or indeed often, parallel. Market conditions and laws of supply and demand have greater weight than chemical composition, and frequently anomalies exist, as for instance, when, a few years ago, cotton seed meal carrying forty per cent. protein was sold at lower figures than corn meal with less than ten per cent. of the same nutrient.

In the fertilizer trade the three deficient essential elements of plant food, nitrogen, phosphoric acid and potash are on the market apart from the others, and their relative money values may be easily and accurately determined.

Wolff, Kuhn, Henneberg and Konig (in Germany), Lindsey (in this country), and others have at various times proposed arbitrary proportional values for the three nutrients, which have been more or less warranted by the facts. These values, however, have usually been largely assumptive. As a rule carbohydrates have made unity and fat and protein its multiples. In some cases digestible components and in some total crude nutrients have been made the basis of computation.

The ratios proposed differ radically, and in 1878 an attempt by committee was made to lay down some rational mathematical rule. This resulted in the application of the "Method of Least Squares" to the problem, and in what appeared to be a very satisfactory solution. Several of the Stations in this country have worked out valuations for feeds by this method. This Station has this year (1896) put a considerable amount of time studying the applicability of this method to present prices, and finds in brief that it is *entirely inapplicable* to the conditions of the market prices of the common feeding stuffs of Vermont during the winter and spring of 1895-6. Just why this should be is not clear, yet a great many combinations of feeds were tried without success, "negative values" for fat being found throughout. We have no method to recommend in its place as yet. Several sets of arbitrary ratios have been tried and found mathematically correct, although some seem practically absurd. A further discussion of the subject with the mathematics leading to these conclusions will be found under the heading "The Method of Least Squares as a Means of Determining the Money Values of Commercial Feeds," further along in this volume.

In this connection it may be said that the worth of the valuation system as applied to the commercial feeds may well be questioned. Nine times out ten feed should be bought to balance a ration, to supply protein. From this standpoint digestible protein, and to some extent digestible fat, are the measures of the relative values of feeds, and may serve as well as dollars and cents as an aid to rational choice.

4. FERTILIZING VALUE OF VARIOUS FEEDS

The fertilizing values in fodders and feeds are too often lost sight of, but, until more generally recognized, they cannot be too often emphasized. Nitrogen, phosphoric acid and potash are the very essence of real estate. Approximately $400,000 are yearly sent out of the State for them in the form of commercial fertilizers, and many times that sum is being needlessly lost yearly in the State by the improper handling of manures, the reckless sale of farm produce and the unwise selection of purchased feed. The percentages of nitrogen, phosphoric acid and potash in commercial feeds are, therefore, well worthy of consideration. It should be noted moreover that the nitrogen, even before it has served the purpose of food, is quite as readily available as the best organic forms of commercial fertilizers, while the potash and phosphoric acid are available without much loss of time; also, that after passing through the animal they are still available to the plant.

The following table shows from the standpoint of fertility the average analyses of the feeds reported in this article. It also shows the money values of the fertilizing ingredients at ruling prices for similar availability in commercial fertilizers (14 cents for nitrogen, 4½ cents for phosphoric acid and 4½ cents for potash) shown, and the average selling prices:

	Nitrogen. %	Phosphoric Acid. %	Potash. %	Estimated Value of Fertilizing Ingredients.	Selling Price Per Ton.	Proport'n of Selling Price Returned as Fertilizer.
Wheat Bran	2.70	0.87	1.37	$9.58	$15.94	60
Wheat Middlings	2.92	0.82	0.81	9.65	17.86	55
Wheat Food	2.86	1.52	1.50	10.73	....	..
Wheat Meal	2.11	0.55	0.42	6.77	.....	..
Corn Meal	1.58	0.52	0.39	5.24	16.50	32
Corn and Oats	1.65	0.58	0.51	5.61	16.70	34
Mixed Feeds	2.27	0.77	0.99	7.97	16.97	47
Linseed Meal (old process)	5.76	0.98	1.24	18.13	24.00	76
Linseed Meal (new process)	6.18	....	....	.....	21.00	..
Cotton Seed Meal	6.83	0.90	1.47	21.25	23.30	91
Gluten Meal	....	....	....	....	21.99	..
Gluten Feed	3.82	0.69	0.35	11.64	19.00	61
Animal Meal	4.66	7.41	1.82	21.36	45.00	48
Buckwheat Flour	1.16	0.26	0.23	3.69	.....	..
Corn Oil Cake	3.63	1.43	0.26	11.67	....	..
Cotton Seed Bran	1.98	0.75	1.26	7.35	17.00	43
Dairy Feed	4.59	1.77	1.04	15.38	.....	..
Chicago Maize Food	3.37	0.49	0.07	9.94	.....	..
Ground Oats	2.07	0.69	0.55	6.92	.....	..
Rye Feed	1.79	0.26	0.52	5.71	.....	..
Rye Meal	1.86	0.76	0.51	6.17	.....	..
Rye and Indian Meal	....	....	....	....	....	..

The column headed "Estimated Value of Fertilizing Ingredients" is intended more as a means of comparison of the different foods from the standpoint of fertility, than as a strict expression of the actual money returns which may be expected. The fertilizing value and the manurial value are not one and the same. The various feeds contain essentially the percentages and fertilizing values given above, but the manure resulting from their use will not contain all. Some will be used in supporting the animal or in making milk, while some, and often far too much, is lost in the handling and storage. There is no reason, however, why with careful management in butter dairying, from four-fifths to nine-tenths of the total fertilizing ingredients in the feed may not, after passing through the animal, be placed upon the land.

5. ECONOMICAL PURCHASE.

It is difficult to grow a sufficient supply of protein upon Vermont farms to enable the carbohydrates to be profitably fed out. Consequently this nutrient should be the main one in mind in selection for purchase. Protein contains 16 per cent. of nitrogen, the most costly deficient element of plant food. Economical purchase of commercial feeds then consists of the selection of such feeds as will afford the most of the deficient nutrients and deficient elements for the dollar invested, with due regard to the character of farm supplies, soil and crop wants, nature of animals fed and work wanted. The purchase and use of concentrated by-products might easily be overdone and sickness of animals and deterioration of produce ensue; but within reasonable limits the more nitrogenous goods are usually the most economical. Profitable animal husbandry and maximum crop raising are both rendered more sure by judicious purchase at present prices of such materials as wheat bran, cotton seed, linseed and gluten meals.

PIG FEEDING.

BY J. L. HILLS.

The experiments in pig feeding made in 1895 were in continuation of those made for several years previous at this Station, corn, bran and dairy by-products being used as feeds. They were planned to answer the following questions:

1. **What are the relative feeding values of corn meal and whole corn; and if the former is found to have greater value, is the gain equal to the cost of grinding?**

2. **What are the relative feeding values of skim-milk and butter-milk?**

3. **What are the relative merits of feeding meal wet or dry?**

In this series of experiments the answers obtained were as follows:—

1. **At the same price for meal and corn, results were slightly in favor of meal.**

2. **Butter-milk and skim-milk had practically equal feeding values.**

3. **Feeding meal wet proved more satisfactory than dry feeding.**

HISTORY.

Fourteen pigs were used in this experiment, all of which were bought by Hon. Cassius Peck, of Brookfield.

Nos. 1–5 were crossed Yorkshire and Chester White; Nos. 6–10 were Berkshires, and Nos. 11–14 were Chester Whites. The first ten were about six weeks old, and the last four twelve weeks old when experimental feeding began. They had all been fed alike for some weeks previous with such amounts of skim milk as they would readily eat, thus getting into fairly uniform condition and used to their quarters. The skim milk used was mostly from the separator.

The pigs were divided into lots of six, four and four.

Lot A. Nos. 1, 6 and 7 received skim milk, corn meal and bran; Nos. 2, 8 and 9 received skim milk, whole corn and bran.

Lot B. Nos. 3 and 4 received butter milk, corn meal and bran; Nos. 5 and 10 received skim milk, corn meal and bran.

Lot C. Nos. 11 and 12 received skim milk and corn meal (wet); Nos. 13 and 14 received skim milk and corn meal (dry).

Each pig of Lots A and B was fed daily 6 quarts of skim milk (7 quarts butter milk taking its place with Nos. 3 and 4) and 12 ounces of corn meal (or whole corn, Nos. 2, 8 and 9) for 18 days, and then to this was added equal parts of corn meal and bran in increasing amounts as the pig grew, until it weighed 200 pounds, after which its further needs were supplied by skim milk (or butter milk) and corn meal alone, each pig being given all of the latter it would eat. The basal ration of 6 quarts of skim milk (or 7 quarts of butter milk) and 12 ounces of corn meal continued throughout. Nutritive ratios varied from 1 :2.6 to 1 :6.5.

Each animal in Lot C received 12 quarts skim milk daily throughout the test. During the first 17 days each ate 24 ounces of corn meal, which was increased as the animal needed until the close of the test. No bran was fed. Nutritive ratios varied from 1 :2.6 to 1 :5. Lots A and B were fed experimentally from June 22 to Dec 20, and Lot C from June 22 to Nov 9.

Owing to the low price of pork, all the pigs were fed until heavier than any lot previously raised at this station. The hoped-for rise in price did not come, however, and the profits were less than we have hitherto received.

I. DAILY RATIONS OF PIGS.

Period.	DATE.	Pigs 1, 6 and 7.				Pigs 2, 8 and 9.			
		Skim Milk. qts	Corn Meal. oz.	Bran and Corn Meal. oz.	Nutritive Ratio.	Skim Milk. qts	Corn. oz.	Bran and Corn Meal. oz.	Nutritive Ratio.
I	June 22-23	4	8		1:2.6	4	8		1:2.6
	June 24-July 9	6	12			6	12		
II	July 10-21	6	12	18	1:3.3	6	12	2 24 8-9 18	1:3.5
	July 22-August 1	6	12	21		6	12	2 27 8-9 21	
	August 2-19	6	12	1-7 21 6 24		6	12	2 30 8-9 21	
III	August 20-27	6	12	1-7 30 6 32	1:3.7	6	12	2 39 8-9 30	1:3.7
	August 20-Sept. 17.	6	12	42		6	12	2 48 8-9 42	
	Sept. 18-24	6	12	1 51 6-7 57		6	12	2 64 8-9 49	
IV	Sept. 25-30	6	12	1 48 6-7 60	1:4.3	6	12	2 70 8 48 9 40	1:4.3
	Oct, 1-5	6	12	1 62 6-7 74		6	12	2 86 8-9 62	
	Oct. 6-19	6	12	1 79 6-7 85		6	12	2 92 8-9 74	
V	Oct. 20-22	6	1 84 6-7 101		1:5.9	6	2 96 8-9 72		1:5.6
	Oct. 23-29	6	1 97 6-7 120			6	2 96 8-9 84		
	Oct. 30-Dec. 20	6	1 120 6-7 132			6	2 108 8-9 96		

Period.	DATE.	PIGS 3 AND 4.				PIGS 5 AND 10.			
		Butter Milk.	Corn Meal.	Bran and Corn Meal.	Nutritive Ratio.	Skim Milk.	Corn Meal.	Bran and Corn Meal.	Nutritive Ratio.
		qts	oz.	oz.		qts	oz.	oz.	
I	June 22-23	4	8		1:2.6	4	8		1:2.6
	June 24-July 9	6	12			6	12		
II	July 20-21	7	12	3 18 4 24	1:3.5	6	12	18	1:3.5
	July 22-August 1	7	12	3 21 4 27		6	12	21	
	August 2-19	7	12	30		6	12	5 24 10 21	
III	August 20-27	7	12	39	1:3.8	6	12	5 32 10 30	1:3.7
	August 28-Sept. 17	7	12	48		6	12	42	
	Sept. 18-24	7	12	62		6	12	5 51 10 57	
IV	Sept. 25-30	7	12	70	1:4.4	6	12	10 60 5 48	1:4.3
	Oct. 1-5	7	12	86		6	12	10 74 5 62	
	Oct. 6-19	7	12	92		6	12	10 86 5 80	
V	Oct. 20-22	7	127		1:6.5	6	103		1:6.4
	Oct. 23-29	7	144			6	120		
	Oct. 30-Dec. 20	7	144			6	132		

Period.	DATE.	PIGS 11 AND 12.			PIGS 13 AND 14.		
		Skim Milk.	Corn Meal, Wet.	Nutritive Ratio.	Skim Milk.	Corn Meal, Dry.	Nutritive Ratio.
		qts.	oz.		qts.	oz.	
I	June 22-23	10	20⅛	1:2.6	10	20⅛	1:2.6
	June 24-July 8	12	24		12	24	
	July 9	21	48		24	48	
II—	July 15-August 19	12	60		12	48	
III	August 20-23	12	72	1:3.9	12	60 1:3.8	1:3.8
	August 24-Sept. 24	12	84		12	74	
IV	Sept. 25-30	12	94	1:4.6	12	88	1:4.6
	Oct. 1-7	12	98		12	96	
	Oct. 8.20	12	120		12	120	
V	Oct. 21-30	12	130	1:5.	12	132	1:.5
	Nov. 1-9	12	132		12	132	

II. GAIN IN LIVE WEIGHT BY PERIODS.

Length of Period in Days.	Pig No. 1.			Pig No. 6.			Pig No. 7.			Pig No. 2.			Pig No. 8.		
	Beginning of Period.	End of Period.	Gain During Period.	Beginning of Period.	End of Period.	Gain During Period.	Beginning of Period.	End of Period.	Gain During Period.	Beginning of Period.	End of Period.	Gain During Period.	Beginning of Period.	End of Period.	Gain During Period.
18	44	50	6	40	54	14	36	51	15	41	69	27	38	49	11
41	50	98	48	54	110	56	51	103	52	69	113	44	49	99	50
36	98	147	49	110	164	54	103	159	56	113	160	47	99	146	47
25	147	188	41	164	211	47	159	205	46	160	204	44	146	189	43
62	188	302	104	211	343	132	205	284	79	204	295	91	189	298	109
	Pig No. 9.			Pig No. 3.			Pig No. 4.			Pig No. 5.			Pig No. 10.		
18	34	49	15	38	56	18	35	53	18	34	50	16	34	49	15
41	49	99	50	56	112	56	53	110	57	50	98	48	49	99	50
36	99	154	55	112	174	62	110	170	60	98	154	56	99	151	52
25	154	197	43	174	227	43	170	221	51	154	197	43	151	195	44
62	197	292	95	227	367	140	221	348	127	197	331	134	195	325	130
	Pig No. 11.			Pig No. 12.			Pig No. 13.			Pig No. 14.					
18	81	92	11	90	100	10	88	99	11	79	85	6			
41	92	169	77	100	173	73	99	147	48	85	146	61			
36	169	235	66	173	248	75	147	210	63	146	218	72			
25	235	291	56	248	303	55	210	250	40	218	264	46			
21	291	322	31	303	335	32	250	279	29	264	304	40			

III. LIVE AND DRESSED WEIGHTS.

Pig Number..............	1	6	7	2	8	9	3	4	5	10	11	12	13	14
Live Weight.............	302	343	284	295	298	292	367	348	331	325	322	335	279	304
Dressed Weight.....	249	294	230	244	251	233	309	300	283	272	276	286	237	254
Shrinkage in Dressing..	53	49	54	51	47	59	58	48	48	53	46	49	42	50
Percentage Shrinkage..	18	14½	19	17½	16	20½	16	14	14½	16½	14½	14½	15	16½

IV. TOTAL FOOD EATEN, DRY MATTER EATEN TO ONE POUND GAIN AND FINANCIAL RESULTS.

Pig Number.		Skim Milk.	Butter Milk.	Corn Meal.	Whole Corn.	Bran and Corn.	Total Dry Matter Eaten.	Gain in Live Weight.	Dry Matter Eaten for one lb. Gain in Live Weight.	Gain in Dressed Weight.	Dry Matter Eaten for one lb. Gain in Dressed Weight.	* Cost of Food Eaten for one lb. increase in Dressed Weight.	Gain per pound Dressed Weight.	Profit or loss per Pig.
		qts.	qts.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	cts.	cts.	$
1	Yorkshire-Chester White	1088	....	537	....	251	897	258	3.48	213	4.21	4.80	0.20	0.43
6	Berkshire..........	1088	....	590	....	271	959	303	3.17	260	3.69	4.18	0.82	2.13
7	Berkshire.......	1088	....	590	....	266	955	228	4.19	201	4.75	5.38	0.38	–0.76
2	Yorkshire-Chester White	1088	....	....	502	315	922	254	3.63	210	4.39	4.98	0.02	0.04
8	Berkshire.........	1088	....	....	452	237	812	260	3.12	222	3.66	4.22	0.78	1.73
9	Berkshire................	1088	....	....	452	245	819	258	3.18	203	4.03	4.64	0.36	0.73
3	Yorkshire-ChesterWhite	....	1254	644	....	304	1061	329	3.23	280	3.79	4.15	0.85	2.38
4	Yorkshire-Chester White	....	1254	644	....	313	1069	313	3.42	270	3.96	4.33	0.67	1.81
5	Yorkshire-Chester White	1088	...	589	....	271	958	297	3.23	254	3.76	4.28	0.72	1.83
10	Berkshire.......	1088	....	589	....	251	940	291	3.23	244	3.85	4.39	0.61	1.49
11	Chester White	1699	....	699	....	....	942	241	3.91	207	4.55	5.54	0.54	–1.12
12	Chester White...........	1699	....	699	....	....	942	245	3.85	209	4.51	5.49	0.49	–1.02
13	Chester White...........	1696	....	648	....	....	898	191	4.70	162	5.54	6.80	1.80	–2.92
14	Chester White...........	1696	....	648	....	....	898	225	3.99	188	4.77	5.86	0.86	–1.62

WHOLE AND GROUND CORN.

Since Nos. 5 and 10, although in another experiment, were fed on the same materials and under the same conditions as Nos. 1, 6 and 7, the results of all five may be used to compare with those obtained with Nos. 2, 8 and 9, fed on cracked corn. The salient points of the tables on the preceding pages for the average pig of each set are as follows:

	Period	Corn Meal.	Whole Corn.
Gain in live weight per day in pounds........	I	0.72	0.99
	II	1.28	1.17
	III	1.48	1.39
	IV	1.76	1.73
	V	1.90	1.59
Average live weight Dec. 20, (pounds)	....	317	295
Average dressed weight Dec. 20, (pounds).....	....	266	242
Per cent shrinkage,.....	....	16	18
Dry matter eaten per pound of gain in live weight, (pounds)........	... .	3.46	3.31
Dry matter eaten per pound of gain in dressed weight, (pounds)....	....	4.05	4.03
Cost of food per pound increase in dressed weight, (cents)	....	4.61	4.61
Total gain per pig (dressed pork at five cents).	....	$1.02	$0.83

* Bran, $16; Corn Meal, $17.50; Skim-milk, 15 cents; Butter-milk, 13 cents.

The final result is very even, the same amount of food being taken to make a pound of dressed pork in each average, and the cost of food per pound of dressed pork being identical. The slightly greater profit from the average meal-fed pig is due to the larger increase in dressed weight. Pig No. 7 ate as heartily as any other, but made so poor gain as to be fed at a loss. If this one be left out the balance is decidedly in favor of the meal fed pigs.

The usual charge for grinding is from an eighth to a tenth of the meal, to which should be added the cost of cartage. If these be taken into account, the whole corn will frequently prove more economical.

SKIM-MILK AND BUTTER-MILK.

The data afforded by Nos. 1, 6, 7, 5 and 10 may be used to compare with Nos. 3 and 4, and we find the following figures:

	Period.	Skim Milk. *	Butter Milk.	Skim Milk.†
Gain in live weight per day in pounds.	I	0.72	1.00	0.86
	II	1.28	1.38	1.20
	III	1.48	1.70	1.50
	IV	1.76	1.92	1.74
	V	1.90	2.15	2.12
Average live weight Dec. 20 (pounds)		317	358	328
Average dressed weight Dec. 20 (pounds)		266	305	278
Per cent shrinkage		16	15	15½
Dry matter eaten per pound of gain in live weight (pounds)		3.46	3.33	3.23
Dry matter eaten per pound of gain in dressed weight (pounds)		4.05	3.87	3.81
Cost of food per pound increase in dressed weight (cents)		4.61	4.24	4.34
Total gain per pig (dressed pork at five cents)		$1.02	$2.10	$1.66

Whether the five or the two which were strictly in this test are compared with the butter-milk fed animals, we find the latter outstripping their fellows. They grew faster and larger, shrunk less, were fed more economically (butter-milk being rated at 13 cents a hundred while skim-milk was rated at 15 cents) and gave a better profit. If rated at 15 cents a hundred the cost per pound of dressed pork becomes 4.51 cents, and the profit per pig $1.31. In this test, therefore, the butter-milk had practically the same feeding value as skim-milk. It has been found in most experiments previously made to have a somewhat lower value.

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* Nos. 1, 6, 7, 5 and 10. † Nos. 5 and 10.

WET AND DRY GRAIN FEEDING.

The salient points of the life history of pigs 11 to 14 are given below:

	Period.	Wet Meal.	Dry Meal.
Gain in live weight per day in pounds	I	0.58	0.48
	II	1.83	1.33
	III	1.96	1.88
	IV	2,22	1.72
	V	1.50	1.64
Average live weight Nov. 9 (pounds)	....	329	291
Average dressed weight Nov. 9 (pounds)	....	281	245
Per cent shrinkage	....	14½	16
Dry matter eaten per pound of gain in live weight (pounds)	....	3.88	4.35
Dry matter eaten per pound of gain in dressed weight (pounds)	....	4.53	5.15
Cost of food per pound increase in dressed weight (cents)	....	5.52	6 33
Total loss per pig (dressed pork at five cents)	....	-$1.07	-$2.27

The experimental feeding of these pigs began when they weighed on the average 85 pounds, and the benefit of the relatively most profitable period was lost to the experiment. To this and the low price of pork may be ascribed the financial loss. The result of the two methods of feeding is clear. The wetting of the meal is distinctly better practice than to feed it dry, as shown by greater and more economical growth and less shrinkage.

Although not strictly comparative as even numbers of both were not on opposite sides, it is worthy of note that on the whole in this test the average Berkshire was fed more economically than the average Yorkshire-Chester White cross.

PROPER TIME TO MARKET PORK.

For several years the Station has laid stress on the rapid growing and early selling of pork, and has shown that even where it sold at comparatively high prices the profits were not large as the pig grew much over 200 pounds in weight. Prices were low when the present lot arrived at the 200 pound mark, and they were kept longer and grown heavier in the vain hope that better prices might be obtained. The following table clearly shows that at five cents a pound for dressed pork there was positive loss in keeping the pigs beyond 200 pounds weight, and that the longer they were kept the greater the loss.

Period.	Average weight at end of each period. Pounds.	Average cost of food consumed for each pound increase in live weight, Cents.	Average selling price per pound of live weight. Cents.	Average gain (or loss) per pound increase in live weight. Cents.	Total gain (or loss) during period.
I beginning	51				
I end	65	4.12	4.20	0.08	$0.16
II	120	3.41	4.20	0.79	6.08
III	185	3.18	4.20	1.02	9.28
IV	224	4.83	4.20	-0.63	-3.44
V	316	4.77	4.20	-0.57	-7.34
Profits					$4.74

The cost of feeding the average pig for a day increased rapidly as the animal grew older. I, 3.17 cents; II, 4.57 cents; III, 5.75 cents; IV, 7.50 cents; V, 8.70 cents.

Had we been able to predict the continued low state of the market, it would have been money in our pocket to have marketed these pigs at the end of the third period late in September, as the profit would have been $15.52 or $10.78 larger than when finally sold. The experiment seems to show that even at the low price of five cents for dressed pork, there is money in pork if sold early enough.

FINANCIAL SUMMARY.

The balance sheet of the present experiment is not satisfactory, owing to reasons already stated.

The fourteen pigs increased in live weight 3,713 pounds, which sold for $156.00. Reckoning corn meal and whole corn at $17.50, bran at $16.00, skim and butter milk at 15 and 13 cents respectively, the food they ate cost $150.99, leaving a profit of but $5.01.

If the original cost of the pigs is taken into account, a method of figuring which applies only when purchase is made yearly, the calculation would be as follows;

3,718 pounds of dressed pork at five cents		$185 90
Cost of pigs	$ 28 00	
Food for pigs	150 99	178 99
		$6 91

VALUE OF SKIM-MILK AND BUTTER-MILK.

The main purpose for which pigs are kept in this State is as a profitable means of utilizing dairy by-products. It would be a fair and is, indeed, a common method of figuring to subtract the cost of grain from the total receipts, allowing manure to offset care, and calling the remainder the value received for skim and butter milks.

Hitherto we have found this value to be 25 cents and upwards per hundred pounds. No such figure was obtained in this test however, because of low prices and prolonged feeding. Yet even the low amount returned is greater than most dairymen ascribe to it.

3,071 pounds increase in live weight, sold for	$128 50
5,597 pounds corn meal, 1,406 pounds of whole corn, 2,091 pounds corn and bran	79 00
15,494 quarts skim-milk were worth	$49 50

or **15** cents per 100 pounds.

642 pounds increase in live weight, sold for	$27 50
1,288 pounds of corn meal, and 617 pounds of corn meal and bran, cost	16 44
2,508 quarts of butter milk were worth	$11 06

or **24** cents per hundred pounds.

It is probable that the relatively high value apparently placed on butter milk is due to the individual excellence of the animals fed upon it, and to the handicap already mentioned in the late initiation of the feeding experiment with Nos. 11–14. Omitting these the value of skim-milk as fed to the remaining eight pigs was **20** cents per hundred.

FERTILIZING VALUE OF FEED.

The foods which were used were rich in plant food, much of which was capable of being saved. Skim-milk and butter milk are worth 11 and 10 cents per hundred, corn meal 30 cents and bran 60 cents per hundred as fertilizers (1895 trade values). The total fertilizing value of the food eaten was $79.04. The food cost $150.99. Its manurial value was, therefore, **52** per cent of its market price as food.

REPORT OF THE BOTANIST.

L. R. JONES.

The results of the investigations of the past year in the botanical department are discussed under the following heads:

I. Potato Blights.
  1. Relation of Late Blight to the Weather.
  2. Selection of "Seed" as a Preventive of Late Blight.
  3. Various Forms of Potato "Blight" and their Causes.
  4. Potato Blights in other States.

II. Bordeaux Mixture.
  1. Methods of Preparing Bordeaux Mixture.
  2. A Field Test of Bordeaux Mixtures on Potatoes.

III. The Disinfection of Seed Potatoes.
IV. Orchard Diseases and Remedies.
  1. Results of Spraying Pear Trees with Bordeaux Mixture.
  2. Frost Injuries to Apples and Pears.

V. Some Observations Regarding Oat Smut.
  1. Relative Amounts of Smut in Oats as grown in Vermont and at more Western Stations.
  2. General Occurrence of Oat Smut in Vermont in 1895.
VI. Onion Mildew in Vermont.
VII. The Hawkweed or Paint Brush.

I. POTATO BLIGHTS.

1. RELATION OF THE LATE BLIGHT TO THE WEATHER.

It is a matter of common observation that the fungus causing late blight (*Phytophthora infestans*) develops rapidly on potatoes only under certain climatic conditions. These conditions are represented by what is popularly termed "muggy" weather, i. e., high temperature with a saturated atmosphere and frequent showers. Until such conditions prevail the fungus, even if present to a considerable extent in a field, does not cause any serious blighting of the plants and does not produce spores in such numbers as to lead to much rotting of the tubers. Such adverse conditions for the fungus prevailed here in 1894, for example, when in spite of a badly infested seed from the crop of 1893 no blight and but little rot was observed.

This fact explains why the late blight is confined to so narrow a belt in this country, the present testimony indicating that this potato disease usually causes but little trouble outside of New England, Northern New York and the adjacent portions of Canada, the diseases popularly known as blight or rot of potatoes outside of this region being attributable to some other cause. In order to study more carefully these peculiar climatic conditions which lead to the development of the fungus the following charts were prepared showing for several years past the conditions of rainfall and temperature which have occured during the period in which the disease has appeared and passed its worst stage. The date of the appearance of the blight and the rapidity and extent of its development are also indicated.

The records at hand give the mean daily temperatures and the daily rainfall, but do not show the humidity of the atmosphere. Theoretically, the conditions most favorable for the development of the fungus are a warm, moist atmosphere with precipitation enough to keep the surface of the plant moist. Although no data as to its humidity were at hand the amount of moisture in the atmosphere is directly indicated by the relative rise and fall of the temperature and rainfall curves outlined in the accompanying charts. Thus a copious and long continued rainfall or a slight fall in temperature accompanied by a heavy rain indicates an atmosphere heavily charged with moisture; accordingly we may expect to find that potatoes were attacked by the blight when the above conditions, i. e., abundant rain and comparatively high temperature are indicated. An examination of the charts, and of the records showing the date of the occurrence of the disease from year to year, proves this to be the case

1891. The temperature was low and rainfall slight the last of July and first of August. August 10th, however, the weather became very warm and on the 12th and 14th was followed by a fall in temperature and copious rains, and this followed by another rise in temperature and more rains about the 21st. The conditions favoring the blight began thus about the 12th. The blight was first observed the 16th or 17th. When it is remembered that such a fungus requires several days in which to get under way before noticeable injury appears, it is seen that the records place the occurrence of the blight at the time when it might be expected.

1892. Late July and early August were very warm but there was little rainfall and a comparatively dry atmosphere. From August 6th to 12th almost ideal conditions prevail for the blight and reference to the records shows that it in reality appeared August 10th, and progressed with unpre-

Charts showing relations of rainfall and temperature to the appearance of the fungus causing the late blight, *Phytophthora infestans D. By.* The time and rapidity of development of the disease is shown by the contour of the shaded portions.

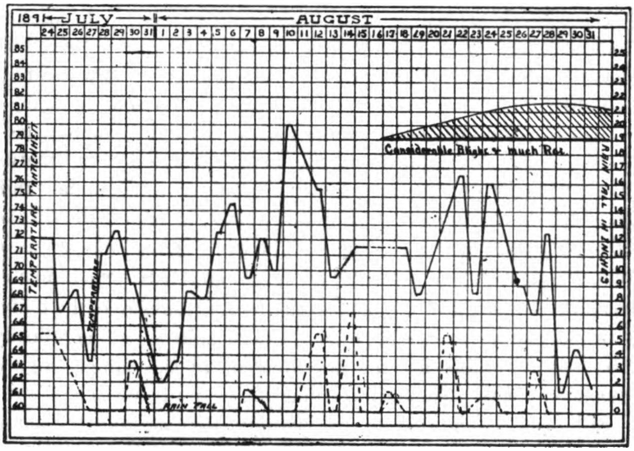

CHART FOR THE SEASON OF 1891.

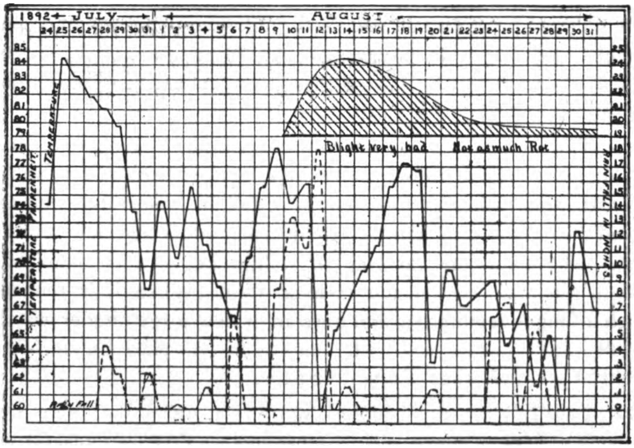

CHART FOR THE SEASON OF 1892.

Charts showing relations of rainfall and temperature to the appearance of the fungus causing the late blight, *Phytophthora infestans*.

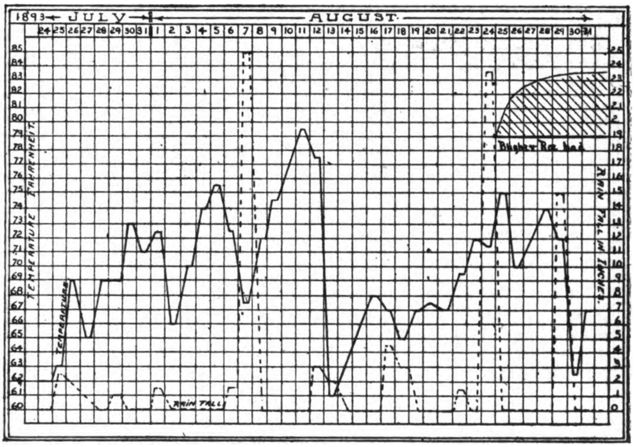

CHART FOR THE SEASON OF 1893.

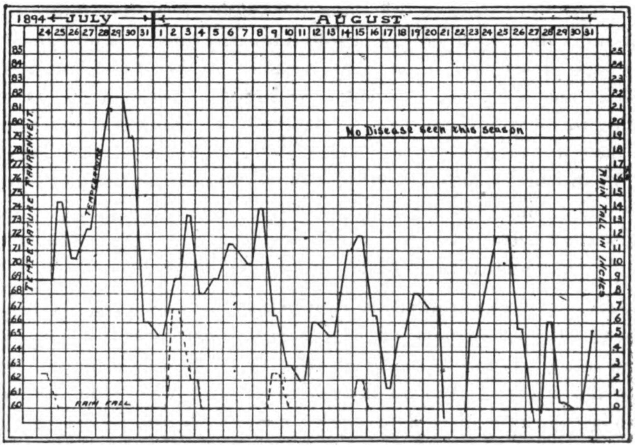

CHART FOR THE SEASON OF 1894.

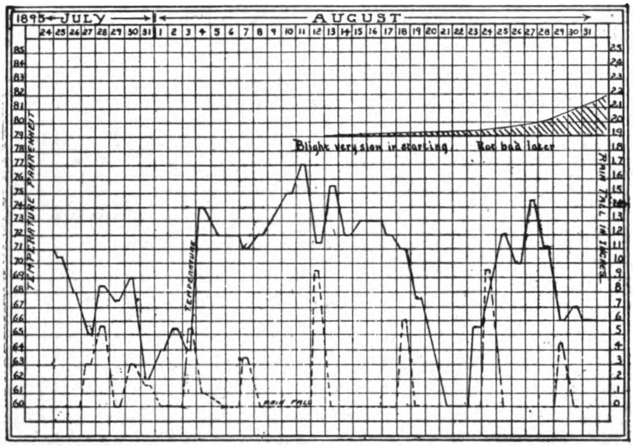

CHART FOR THE SEASON OF 1895.

cedented rapidity so that almost every potato plant was destroyed by it before August 20th.

1893. There were conditions favorable for the disease from August 7th to 13th, but no blight was observed at that time. However, early potatoes whose tops were dead at the time the blight was first noticed, August 25, showed quite a percentage of rotten tubers; thus it is probable that the blight was present on these early potatoes at the period indicated by the charts as favorable, but escaped observation. Another bit of evidence pointing this way is the fact that a piece of late potatoes adjacent to these early ones was attacked by the blight fully a week earlier than was another piece in an isolated locality, but planted with the same strain of seed.

The later conditions favoring the blight began about August 22d, and the disease is recorded as under full headway by the 25th, and as continuing into September with unusually destructive results.

1894. July was warm but dry, and August was cool and dry to an extent unknown in the memory of "the oldest inhabitant." These conditions proved so unfavorable to the fungus that no blight was seen upon the leaves during this season. A small amount of dry rot was found in the tubers upon digging them, thus showing that a very little of the fungus did occur.

1895. Favorable conditions for the blight were present from the 7th to the 20th of August. Very little was seen, however, until the last of the month. This tardiness, in the development of the disease, must be accounted for by the fact that there was so little chance for the fungus to grow during the preceding summer that a remarkably small number of diseased tubers were present in the "seed" planted in 1895. The original centers of infection in the fields were therefore few and scattered. It was nevertheless true that this slow development of the fungus on the leaves was followed by a very bad rotting of the tubers.

This last condition is however not uncommon and is to be explained by the fact that during the slow progress of the disease on the leaves a continuous discharge of spores upon the soil occurs, while in case of the more rapid destruction of the vines there is a correspondingly shorter period of this soil infection and correspondingly less rot of the tubers results.

The question is frequently raised whether there is not danger of the disease being introduced to the portions of the country where it does not now prevail by importation of seed tubers from sections where the disease is common. The experience of 1894 already referred to effectually denies any such probability. The seed tubers grown by us in 1893 were badly infected with rot, and we should undoubtedly have suffered seriously in 1894 if conditions had favored. With unfavorable climatic conditions the disease was completely checked and had similar conditions prevailed in 1895, we feel confident that the fungus would have been practically exterminated in this vicinity. Unquestionably such a fate has overtaken it in all the dryer states of the south and west, whenever it has been introduced in infected seed, and such will continue to be the case wherever the climatic conditions are adverse to the fungus.

2. SELECTION OF "SEED" AS A PREVENTIVE OF LATE BLIGHT.

As opposed to the closing statement of the preceding article, however, we wish to state that the experience of 1894-5 teaches emphatically that where the climatic conditions are favorable to the blight as they are in Vermont, a great deal of the loss from the disease can be prevented by proper selection of the seed for planting. Our argument is based on the following experience: Early in August, 1895, the warm rainy weather which usually leads to the blight set in and persisted with more or less continuity throughout the month. Yet there was no general outbreak of the late blight.

How is this to be explained? As stated in previous accounts of this disease, the fungus causing it lives over winter in diseased potato tubers, and so far as known, only in this way. Owing to the continued drought of 1894, there was during that season but little opportunity for the development of the late blight and the accompanying rot. Consequently the seed potatoes raised in this vicinity in 1894, and planted in 1895, were almost entirely free from this disease.

Had they been absolutely so there would have been no appearance of the blight in 1895. But careful examination of our own crop in the autumn of 1894 showed that there was an occasional case of "dry rot" among the tubers. This indicated the presence of enough of the disease to insure its survival through the winter in many of the apparently healthy "seed" potatoes. There were, however, so few diseased tubers planted as compared with ordinary years, and these original centers of infection were consequently so much fewer in the fields, that the blight was fully two weeks later in getting under headway than is ordinarily the case under the same climatic conditions. One early piece of potatoes upon which we were experimenting blighted quite badly in August. On all the other plots there was no destructive spread of the late blight before September 1st. Once well started, however, the disease spread persistently through September, and caused a large amount of rot in the later potatoes, while the early ones were practically free from the disease.

The experience of this year teaches a most important lesson, which if generally heeded would save Vermont potato growers from the loss of thousands of dollars annually, viz.: that *seed potatoes should be taken from a field which did not suffer from the late blight and the rot.* In the vicinity of Burlington the earliest planted potatoes, especially if on a light, dry, sandy soil, usually escape the late blight. Similar conditions exist throughout the State, and seed potatoes should be selected from such a source. If this were to become the *general practice* the saving would be incalculable. Unfortunately the careful individual must often suffer because of the continued propagation of contagious diseases, whether of plants or animals, by ignorant or slothful neighbors. One man alone cannot suppress an epidemic. Concerted action is necessary for the best results. There was, however, such a marked difference last year in the date of the appearance of the late blight in this vicinity upon plots of potatoes separated by only a short distance, that we believe that with potato fields more widely separated, as they are on ordinary farms, each man can do much by use of healthy seed to save his own crop in spite of the bad practice of less intelligent neighbors. Careful choice of seed, and in many cases the growing of a small piece of potatoes for seed purposes, is therefore strongly recommended as a preventive measure against the late blight and rot.

It is vain, however, to hope that any such precautionary measures as selection of seed will do more than delay for a time the outbreak of the late blight upon the average Vermont potato field when the weather is favorable.

3. VARIOUS FORMS OF POTATO "BLIGHT" AND THEIR CAUSES.

Owing to the complications of the characteristic "early blight" of the potato with injuries due to drought, insect attacks and arsenical poisoning, a careful study of the various causes leading to the premature death of potato leaves and of the fungus growths found upon dead or dying leaves was undertaken during the summer of 1895. The diseased conditions prevailing in the vicinity of Burlington were first studied carefully, and, later, the studies were extended to various localities in this and other states.

The details of these investigations were largely entrusted to Mr. C. C. Tracy, who was employed as botanical assistant during the summer and later continued the studies as preparation for his graduation thesis in the Agricultural Department of the University.

Much credit is due Mr. Tracy for the patient and thorough manner in which these investigations were pursued, and it is with deep sorrow that we add that the final completion of these studies was interrupted by his sickness and death.

Mr. A. J. Grout has been employed to assist in a portion of the work of 1896, and in so far as his laboratory investigations are a continuation of those begun in 1895, the results are included in this report.

The work has consisted of extended field observations coupled with microscopic examinations of diseased leaves to determine the nature of the injuries and the presence of fungus or other injurious agencies; of applications of Paris green under varying conditions and of various strengths, noting injurious effects; and especially of the securing of pure cultures* of such fungi as were found commonly associated with the leaf injuries and the inoculation of potato leaves with such of these as were suspected of having any causal relation to the injuries.

The result of these studies was to clearly distinguish at least three well marked and serious disorders which were passing current under the popular name of "early blight." These are:

1. The typical *Early Blight* or "Leaf Spot" disease.
2. *Arsenical Poisoning* from Paris green, etc.
3. *Tip Burn* from drought, etc.

The general appearance of leaves showing injury from each of these three causes is shown in Figures 1, 2, 3, and 4.

In order to present the practical conclusions from these studies to potato growers Bulletin 49 has been prepared (published December, 1895) in which is described the general cause and appearance of each of these disorders together with suggestions for their prevention.

As supplementary to this bulletin we here give a more detailed account of the observations and studies upon which the more important conclusions there presented were based.

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* In making a careful study of any fungus it is advantageous to secure it in "pure culture"; that is to get a growth of it started in a closed dish upon some artificial food substance and free from mixture with other fungus growths and from bacteria. The structure and development of the fungus can then be more carefully studied and by means of inoculations from such cultures upon healthy plants the disease producing ability of the fungus can be critically tested.

In these studies various culture media were tried, but most of the cultures were made either upon "potato-leaf agar" a decoction of potato leaves stiffened by the addition of from one to two per cent. of agar, or upon "prune agar" a decoction of prunes similarly stiffened.

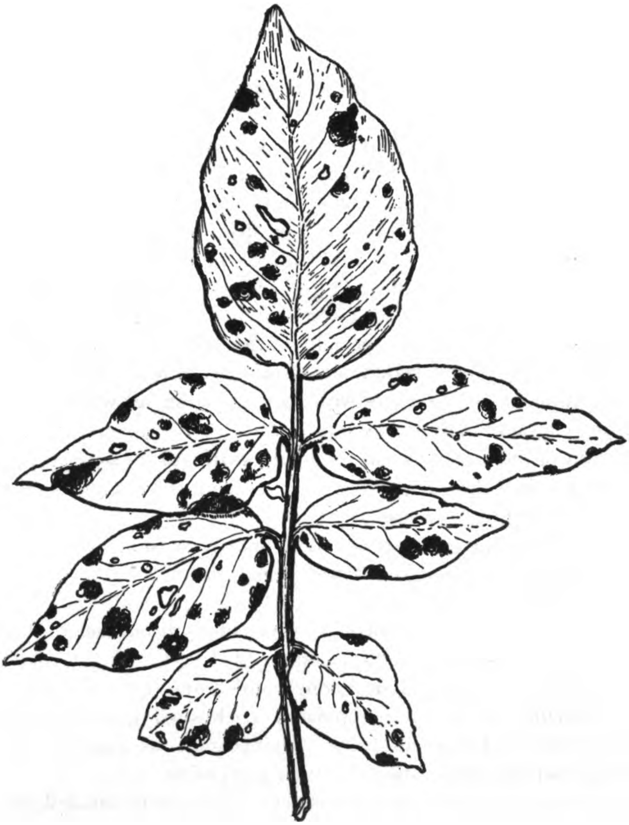

Figure 1. EARLY BLIGHT OF THE POTATO (Leaf-Spot Disease) in its *early stages* on a young leaf. Caused by the fungus *Macrosporium Solani. E. & M.* Compare with Figure 2.

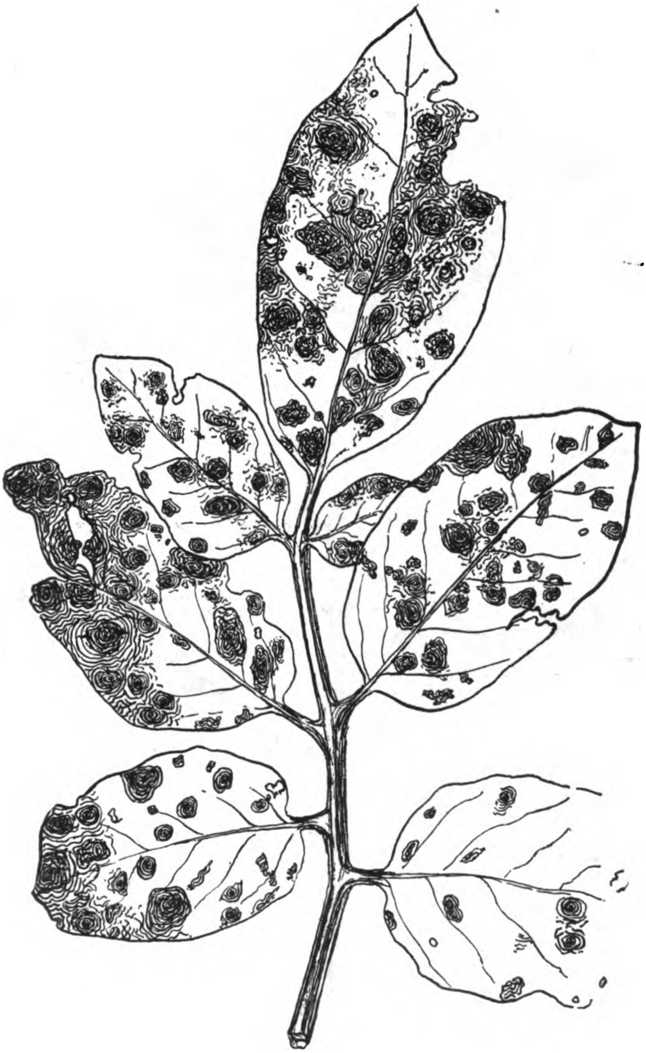

Figure 2. Early Blight of the Potato (Leaf-Spot Disease) in its *later stages* on an old leaf. The rings or "target board" markings very characteristic of such old spots are here shown more distinctly than they appear on the actual leaf. Compare with Figure 1.

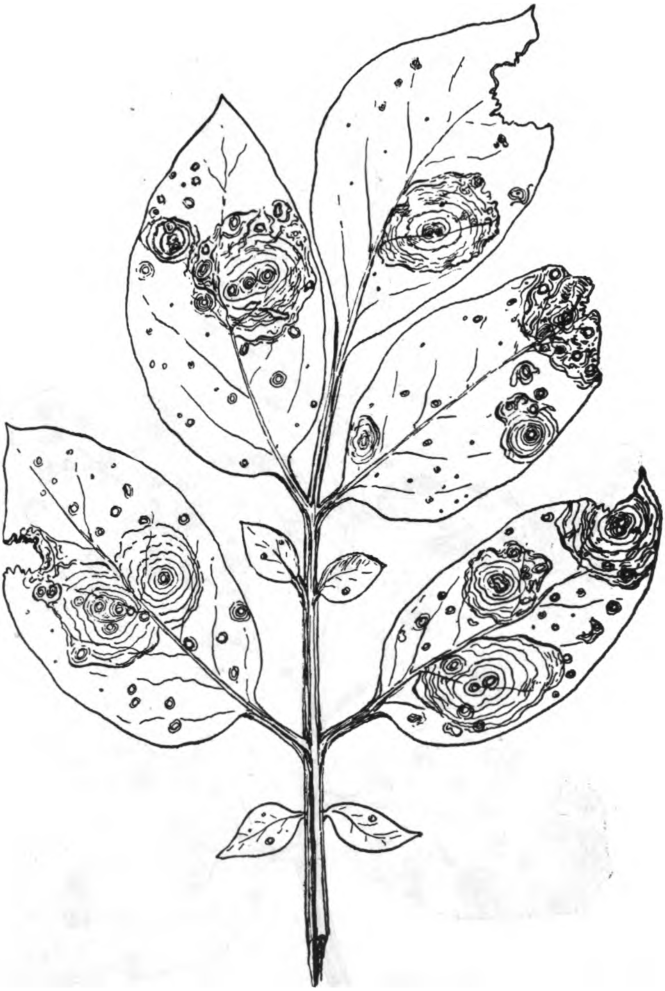

Figure 3. Arsenical Poisoning of the Potato Leaf by improper use of Paris green. The dead spots in the leaf are black or brown. Note that they all originate at flea-beetle punctures or other injuries. Compare with Figure 2 since these two troubles resemble each other so closely as to be easily confused.

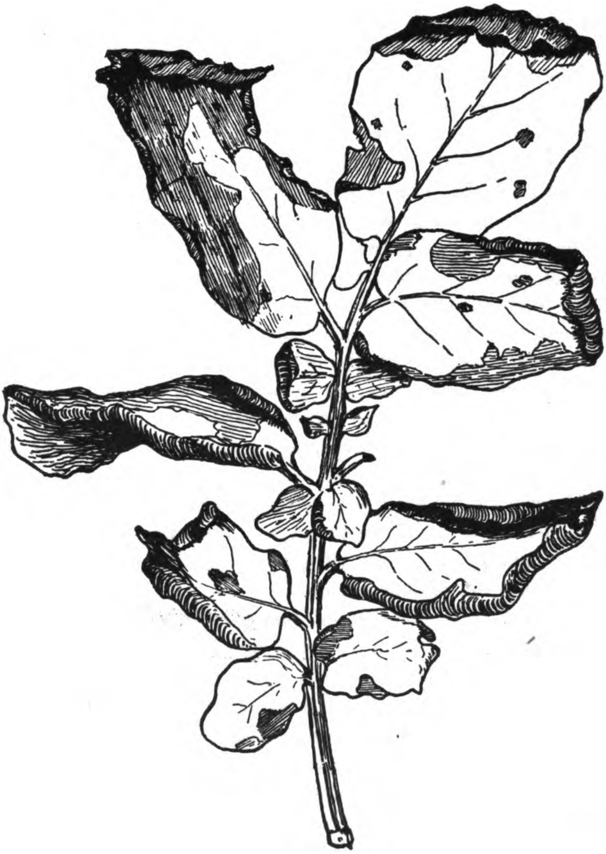

Figure 4. Tip Burn of the Potato Leaf, due to hot, dry weather combined with any other agencies which weaken the plant. Often occurring with Early Blight and commonly confused with it.

POTATO DISEASES AS THEY OCCURRED IN 1895.

Scarcely a trace of *Phytophthora infestans* (the fungus of the late blight and rot) was seen before September first, *upon our experimental plots*. From the middle of July until this date there was abundant opportunity to study the several forms of disorder classed popularly under the name of "Early Blight." The first cause leading to serious killing of the leaves was Paris green. During June and early July nearly every field examined showed abundant evidence of overdoses of this poison. The appearance of the leaves is shown in Fig. 3. In addition to the account given in Bulletin 49 (p. 97) we will only add that experiments with Paris green mixtures applied to leaves of potato plants grown in the green-house this winter show that plants of the same variety grown in the warm, moist atmosphere of the house are much more susceptible to injury than are those grown in the field and that the injurious action is more severe where the epidermis of the leaf is freshly broken. This emphasizes the need for more caution in the use of the poison since the fact that the poison applied in a certain way one year does not injure the plants will not guarantee equal safety from its use under different conditions or with another variety of potato. As stated in the bulletin referred to, the poison should be applied with more care. The earlier applications are best diluted with gypsum or similar powder and applied dry; later it can be used with perfect safety in the Bordeaux mixture. If water is used as a carrier for the poison, an amount of freshly slacked lime, at least equal to the amount of poison used, should be added to the water to neutralize the soluble arsenic.

The tissues killed by Paris green remained practically free from fungus growths so far as observed, but from the middle of July till the killing of the last plants by frost, there was an abundance of dying potato leaves upon our fields, the cause of whose death was neither Paris green nor *Phytophthora infestans*. As stated on a previous page and described in Bulletin 49, two forms of malady were constantly found—one the "Early Blight," properly speaking, the other "Tip-burn." See Figures 2 and 4. The two were about equally in evidence upon the Experiment Station field. In some other fields seen one or the other of these maladies was alone responsible for most of the loss. The gross appearance and favoring conditions and remedies for these disorders have been described in Bulletin 49. It only remains to discuss in detail the laboratory studies pursued.

Three species of fungi were very commonly found upon these diseased potato leaves. They were *Macrosporium Solani E. & M.*, a species of *Cladosporium*, (apparently *C. herbarum*) and a species of *Alternaria*. The *Cladosporium* was clearly a saprophyte, invading only dead tissues and no extended study of it was undertaken.

The marked resemblence of the spores of the other two species made their discrimination very difficult until they were grown in pure cultures.

Studies of the *Alternaria* in such cultures showed it to be a species unable to gain an entrance into living potato leaves, although it is still doubtful if it may not in some cases aggravate or increase the diseased conditions after having gained entrance, and its wide-spread occurence in connection with Tip-burn make it liable to constant confusion with the *Macrosporium* in laboratory investigations. We have felt justified, therefore, in continuing detailed studies upon it even after we were convinced of its saprophytic nature.

For convenience we will give first the results of the studies upon the true early blight fungus (*Macrosporium Solani*) and later the discussion of this *Alternaria*.

STUDIES UPON MACROSPORIUM SOLANI,* E. & M.

This fungus was first described by Ellis in American Naturalist in 1882** as occurring on potato leaves. Its relation to the now familiar early blight of potatoes was recorded in 1891 and 1892 by various observers in this country and Australia.†

The opinion was generally expressed or implied by these observers that the fungus was the cause of the disease, although its association with insect injuries or an otherwise weakened condition of the leaf was constantly noted.

Chester stated in 1891 that he made successful infections of the leaves of tomato plants with the fungus ‡ and Galloway || states that spores sown on healthy potato leaves produce the characteristic spots in eight or ten days.

Dr. Sturgis after reviewing this evidence in 1894§ considers that Chester's inoculations from the manner in which they were made were inconclusive, and that evidence is still lacking to prove that the fungus is the direct and only cause of the disease. He concludes that "it seems possible that the early blight of potatoes may be due to the physiological effects of extreme heat and dryness acting upon leaf tissues at a distance from the roots and already injured by predatory insects, and that tissues so injured are liable to the attacks of certain fungi, which may enhance the injury." After further discussion of Dr. Sorauer's classification of so-called parasitic fungi into

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* Observations recorded later in this Report, show this species also to be an Alternaria, not a Macrosporium as heretofore supposed.

** Am. Nat. Dec. 1882, p. 1003.

† Humphrey in Rep. Mass. Agr. Exp. Sta. 1891, p. 226.

Chester in Rep. Del. Agr. Exp. Sta., 1891, p. 58.

Galloway in correspondence and in Garden and Field, Adelaide, Australia, for June, 1891. See also notes and discussion in Rep. Vt. Exp. Sta., 1891, p. 131 and 1892, p. 66.

‡ Loc. Cit. p. 59.

|| Agricultural Science, Vol. VII., p. 377.

§ Rep. Conn. Agr. Exp. Sta., 1894, p. 132.

three classes, absolute parasites attacking uninjured healthy organs, partial parasites attacking uninjured but unhealthy organs and wound parasites attacking injured organs at the point of injury, he suggests that the early blight fungus may be included "in the second or possibly the third class instead of in the first class as heretofore."

Our own previous observations had led us to consider the fungus an active disease inducing agent, but we had felt the need of more careful study along the lines suggested by Dr. Sturgis, and undertook in 1895 to obtain answers to the following questions:

1. With what forms of potato leaf injuries is the fungus *Macrosporium Solani* associated?

2. Is it possible to produce diseased spots by inoculating healthy living potato leaves growing under normal conditions with spores taken from a pure culture of this fungus?

In obtaining evidence regarding the first point hundreds of potato leaves were collected and examined from our own fields, a large amount of material collected at Burlington and other points in Vermont during previous years was re-examined, and finally examination was made of a considerable material sent from the various experiment stations of the Northern and Eastern States. The results were conclusive. In all cases where the characteristic "early blight" spots occurred in the interior of the leaves, the diseased tissues were found to be invaded by this fungus, and usually by no other in the earlier stages of the diseases. In the earlier part of the season (in July and early August) many of these spots plainly centred about flea-beetle punctures or similar injuries, allowing of no doubt that the fungus gained entrance to the interior tissues at such points of injury, but more spots could be found on nearly all diseased leaves which showed no such relation to insect or other injuries. The leaves which began to spot earliest in the season were the lower, and hence older and more shaded leaves of the plants. There was also an evident preference of the fungus for the weaker leaves, and for the weaker portions of the leaves, i. e., tips and marginal areas. As the season advanced the disease increased and the spots were no longer confined to the lower or older leaves and in a great majority of cases showed no relation to insect injuries, the small green leaves at the summit of the plant, becoming peppered with spots almost as soon as expanded. These facts are in accord with our observations in 1892, that "insect punctures or other injuries to the leaf offer a favorable starting point for this fungus," and that "this disease does little damage [in Vermont] until after the plants blossom and pass their stage of greatest vigor."* The fungus is, however, decidedly more than a wound parasite attacking unmutilated portions of living leaves. As it occurs in Vermont it is well described by a term employed by Dr. Sorauer of Berlin, in a recent letter, as one of the class of "Schwache-parasiten," a German expression hard to translate into English but for which we suggest the term "weakling parasites," i. e., parasites upon weakly organisms.

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*Rep. Vt. Agr. Exp. Sta., 1892, p. 67.

The economic importance of the fungus is scarcely lessened by this fact, however, since the latter part of the life of the potato plant is of the greatest practical importance to the cultivator, and when it is lessened by even a week the loss is serious.*

In order to secure answers to the second question proposed, viz: as to the ability of the fungus to gain an entrance into living potato leaves, pure cultures were started from single spores of the *Macrosporium*. Such cultures produce spores very sparingly in their earlier stages, but later under favorable conditions often sporulate freely.

When the surface of such a spore-bearing culture is rinsed with water an abundance of free spores is easily obtained in the water, and at a favorable temperature these begin to germinate almost immediately. (See Figure 1, of Plate 1.) Inoculations were usually made in our investigations by applying some water thus charged with fresh spores upon the potato leaf by means of a recently sterilized camel's hair brush. Inoculations were repeatedly secured in this way, in which diseased spots infested with the fungus appeared within three to five days after the application of the spores upon leaves which were vigorous at the beginning of the experiment.† In most of this work we were obliged to use potato plants grown in the greenhouse and they were confined for a short time after the inoculation under a bell jar. It is true that a plant thus grown in the winter in the moist atmosphere of the greenhouse is probably less able to resist the invasion of fungi than is a similar plant grown out of doors during the summer months, yet the conditions are not altogether unlike those existing out of doors during a period of rainy weather. While the results of these inoculations made by Mr. Tracy during the winter months had, therefore, answered the second question in a fairly satisfactory manner, it seemed desirable, for the reasons given, to repeat the work with plants grown out of doors. This has been done with the assistance of Mr. Grout during the present summer (1896) and owing to the delay in the publication of this report we are able to add that these infections have been fully as successful as those obtained in the greenhouse. The details of a single experiment will suffice.

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*See discussion of the "Time and Rate of Growth of Potato Tubers," Vt. Bul. 40, p. 26.

†The most serious obstacle in the process of securing inoculations lay in the difficulty of preventing the spores strewn upon the surfaces of the leaves from drying. This was overcome in some of the experiments by placing dishes of steaming water under the bell jar while covering the outside of the jar with a towel wet with cold water, in others a flask of water was kept gently boiling, and the steam thus generated was conducted to the interior of the jar through a glass tube. A very convenient scheme used by Mr. Grout was to draw to a fine hair like point a glass tube of rather large bore. By filling this tube with water and suspending it at an angle with the minute orifice of the capillary end over the leaf a slow dripping of water resulted which was regulated at pleasure so as to replace the water upon the inoculated leaf as rapidly as it evaporated.

In order to force the growth faster and handle the plants more conveniently potatoes were grown in pots, starting them in the greenhouse and later setting the pots in the soil out of doors. The plant in question was about one month old, and in full vigor. The spores were applied in water with a camel's hair brush, as already described, to one of the younger leaves (including its several leaflets) situated near the top of the plant on the northeast side. This was done at 7 o'clock P. M. There was a fairly copious dew that night. As the air was warm and dry the next morning, a large bell jar was placed over the plant and remained there until evening to prevent the thorough drying of the surface of the leaves. Water was dropped from a pipette upon the inoculated leaf at intervals during this day and the next also.

On the sixth day after the application of the spores small black spots were visible on the leaflets. These gradually increased in size and numbers, having in all ways the characteristic appearance of the typical early blight spots caused by the *Macrosporium*, including the "target board markings."

On the ninth day one of the smaller leaflets, which had a well developed spot, was removed and examined. Upon the upper surface of the leaf about the middle of the spot two large *Macrosporium* spores were found, which had germinated freely and several of the germ tubes were traced into the leaf tissues. Moreover, the dead tissue was thoroughly permeated with a fungus mycelium agreeing in all its characters with the mycelium of the *Macrosporium*. A small portion of the tissue from the diseased spot was examined to determine that there were no spores upon its surface and then placed in a culture dish of agar. A luxuriant growth of mycelium soon began to radiate from it, which proved to be *Macrosporium Solani*. Another leaflet was removed on the fourteenth day after the inoculation. Examination of this leaf showed the presence of sporophores bearing spores of the *Macrosporium* protruding from the under surface of the leaf as well as the upper, thus completing a chain of evidence which must satisfy any existing doubts as to the parasitic habit of this fungus.

Attention is further directed to Plate 1, which shows the vigorous germination of the *Macrosporium* spores and the mode of entrance of the germ tubes into the leaf tissues, both through the breathing pores and by direct penetration of the outer walls of the epidermal cells. These drawings were made from a potato leaf inoculated three days previously. Once within the leaf the fungus apparently finds little difficulty in making its way through and between the cell walls in all directions until the tissue is thoroughly permeated by it. The production of spores is usually delayed until the death of the host tissues and is rarely very abundant even then. The spores are produced on sporophores which either push out through the breathing pores or break directly through the outer walls of the epidermal cells, being found in greatest numbers on the upper surface.

Many spots infested by the fungus bear few or no spores, however, and rarely are many found. This paucity of spores is somewhat puzzling in view of the very vigorous development of the mycelium. It is not at all probable, however, that the spore production ceases with the death of the leaf tissues. This event appears rather to mark its active beginning. The most abundant sporulation is always found on the dead tissues of the older spots. Moreover, this mycelium retains its life for a considerable period of time, certainly for a year or more, as shown by placing in culture media bits of old potato leaves infested with the fungus when a vigorous growth of the mycelium has followed. Similar bits of mycelium from culture dishes, eight months old, dry and hard, when placed in fresh culture dishes, resumed growth at once. It is quite probable, therefore, that the mycelium passes the winter in a resting condition in the dead tissues of potato plants and produces spores again the following season. The spores likewise retain their vitality for an indefinite period. Those a year old germinate quite vigorously, although we have not as yet succeeded in inducing those two years old to grow. There seems little need then by the fungus of any special resting stage or other form of spore in order to successfully propogate itself, nor have we seen indications of any such condition either on potato leaves or in culture dishes.*

It is a well known law of plants that excessive nutrition retards the reproductive processes. This is the probable explanation of the fact already noted that the fungus rarely produces spores until it has fully sapped the food supply of its host plant. The same tendency was constantly shown in the cultures dishes. No matter how large the dish there was but slight spore production until the surface of the dish was covered. Interesting exceptions which served to prove the rule occured when the mycelium of the fungus came into contact with a chance colony of bacteria in the culture medium, in which case spore production in this vicinity very commonly ensued.

Even more interesting and of some practical utility in our study was the fact that where the spores were thickly sown in the culture dish so that the colonies resulting from the germination of the spores at once began to come into contact with each other their vegetative growth was promptly checked and spore formation ensued. The peculiar colonies shown in Plate II were examples selected from hundreds of similar colonies so produced in the same dish within three days after starting such a crowded culture.

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* It is of some botanical interest to note that cultures of the so-called *Macrosporium Sarcinula*, *Berk. var parasitibum*, *Thum.*, growing in similar cultures along side the cultures of *M. Solani* formed their characteristic *Pleospora* perithecia within a short time while *M. Solani* showed no signs of any variations in its vegetative or reproductive characters.

Ordinarily the mycelium growing in the culture dish forms a thick felted mass filling the upper strata of the culture medium and rising for a twelfth of an inch more or less above it. This pushes out radiating threads in all directions, the rapidity of growth varying with the temperature, from 1-16 to 1-4 of an inch daily in the colonies studied. A curious phenomenon common to many fungi grown thus in culture dishes is beautifully shown by this *Macrosporium*, viz: the formation of concentric rings* as growth continues, darker and lighter rings occuring alternately as shown in Plate III. Mr. Grout, as a result of his studies, is of the opinion that this is a simple result of the periodicity of growth of the fungus, the light ring representing the more rapid growth which ordinarily occurs during the warmer period of the day and the dark ring resulting from the arresting of the growth at night time. The number of rings in the culture dish thus corresponds to the number of successive days and nights of growth unless some unusually favorable or unfavorable conditions have disturbed the normal alternation of temperatures.

SOME OBSERVATIONS UPON A SPECIES OF ALTERNARIA.

Along with the *Macrosporium* on many of the older leaves and especially on those suffering from "Tip-burn," two other species of fungi, a *Cladosporium* and an *Alternaria*, were often very abundant. The *Cladosporium* was so clearly a saprophyte and in no way connected with the blighting of the leaves that but little attention was paid to it. The spores of the *Alternaria*, however, so closely resembled the *Macrosporium*, and the two were so frequently found associated on the same leaf, that it was made the subject of very careful and extended study. So close was this resemblance that when first seen the question arose whether the two might not be simply different stages of the same fungus. Further study, however, removed all doubt on this point, as the two behave differently when grown side by side on the same culture medium and under exactly the same conditions.

Pure cultures of the two have been carried through many generations during several months of time and each remains distinctly true to the type of the original spores from which it sprang. Moreover, applications of the *Alternaria* spores upon potato leaves made at the same time and under the same conditions as those of the *Macrosporium* failed in all cases to lead to successful inoculations. Although there has been no difficulty in inducing it to grow upon dead areas of living potato leaves it has in no case seemed to lead to the enlargement of such areas, apparently being unable to invade the adjacent living tissue. We are led to conclude, therefore, that this *Alternaria* is a saprophyte and to doubt that it plays even a minor part in the destruction of the living tissues of potato leaves.*

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*The formation of the characteristic "target board" rings in the potato leaf spots is quite a different phenomenon and, as shown in the Figure 3, such rings are produced by Paris green or indeed will doubtless result from any cause leading to the slow death of the leaf tissues if such death proceeds gradually outward from a central point. It is to be explained in our judgment as resulting from the more complete collapse and consequently rapid contraction of the interior cells or mesophyll of the leaf as compared with the outer epidermal cells. The gradual contraction of the mesophyll toward the common center as it dries throws the overlying epidermis into the characteristic ridges. Similar concentric ridges occur in the case of fungus or other injuries to many of our common plants, e. g., they are very common on dandelion leaves. On the other hand the fact was noted that the usual ridges were not formed in the case of Macrosporium spots upon potato leaves growing in the moist atmosphere of the greenhouse. This shows that they have no necessary relation to the invasions of the fungus.

The very close resemblance of the single spores of this *Alternaria* to those of the *Macrosporium* and its very common occurrence upon the dead portions of leaves suffering from tip-burn has undoubtedly been in part responsible for the confusion of the true early blight with tip-burn. We therefore figure it in comparison with the *Macrosporium* in Plates I and II

MACROSPORIUM SOLANI E. AND M. AN ALTERNARIA.

The distinction between the genus *Macrosporium* and the genus *Alternaria* is generally recognized as an arbitrary and very unstable one, consisting merely in the manner in which the spores are borne, the *Macrosporiums* producing their spores singly, the *Alternarias* producing theirs in chains. As the two genera are so similar in other respects the presumption is that many of the species now classed as *Macrosporium* will upon further study prove to produce spores in chains.

The question has naturally been raised by various investigators whether *Macrosporium Solani* did not at some times produce its spores in chains after the type of the *Alternarias*.

In a letter received from Mr. K. Sengoka, a Japanese investigator of the Imperial College of Agriculture, Sapporo, in May, 1895, he stated that he had seen such catenulate spore production in a species which appeared to be identical with *Macrosporium Solani, E. & M.*, and that he proposed to publish it accordingly as *Alternaria Solani.* We have expected to learn of such publication, therefore, but have not as yet.

Dr. Paul Sorauer in "Zeitschrift fur Pflanzen Krankheiten," IV Band, I Heft, has described under the name *Alternaria Solani, Sorauer* two fungi which he considers identical but which we believe to be distinct. One of these fungi which he describes agrees so closely with *Macrosporium Solani* that Dr. Sorauer considers it the same, the other corresponds essentially with the *Alternaria* described above.

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* While continuing these studies the present summer (1896), Mr. Grout found this fungus occurring saprophytically upon dead leaves of onions in the garden near the potato plots. Following this, further search proved it to be of very common occurrence on dead leaves or other tissues of a variety of plants, including besides the onion, cabbage, oat, bean, and other garden plants. Finally, upon undertaking some studies of the *Macrosporium* commonly associated with the Black Rot of the tomato (*M. Tomato, Cooke*), it was found that this also is an *Alternaria* and in no way distinguishable from the preceding when grown upon the same culture media.

Dr. Sorauer concluded from his observations that the two were but varying stages in the development of one and the same species. In the face of our results we cannot believe this to be true, the only evidence we have seen in favor of such relation being the fact that the two are very frequently found associated on dead potato leaves, and that of course has no real weight. In structure and habits of growth the two are quite different and in no case of pure culture has evidence of mutability been observed. In addition we will only state that from potato leaves kindly sent by Dr. Sorauer, collected in Hungary, both species of fungi have been separated and studied in pure cultures, and that in all respects they appear identical with the two species found on American leaves.

There was found, however, in one of our pure cultures of the *Macrosporium Solani E. & M.* which was sporulating luxuriantly, frequent cases where two spores were clearly joined in pairs as shown in the accompanying figures. The occurence of these spores in such a culture leaves no doubt of their identity; moreover their measurements, as well as other characters, correspond with the typical single spore of *Macrosporium Solani* and do not in any way resemble the spores of the *Alternaria* previously described. They, therefore, serve to settle beyond all doubt the fact that *Macrosporium Solani, E. & M.* must hereafter be classed as an *Alternaria* and known as *Alternaria Solani*.

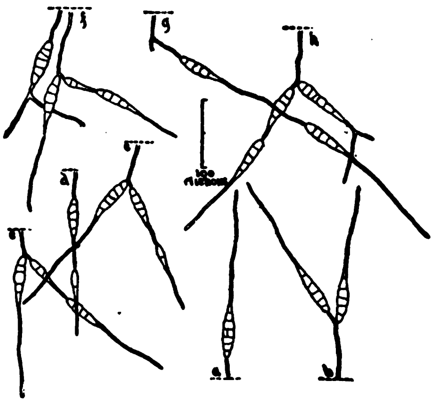

Figure 12. *Macrosporium Solani, E. & M.* grown on Prune-agar, showing spores borne in catenulate pairs after the manner of the *Alternarias*.

We will leave it for some one more expert in the matter of nomenclature than ourselves to decide upon whose authority the name rests.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. Single spore of *Macrosporium Solani, E. & M.*, showing germ tubes protruding from three cells (*a*, etc.) From culture on prune-agar. Magnified 280 diameters.

Fig. 2. Two spores of *M. Solani, E. & M.*, germinating and penetrating surface of living potato leaf. *d*, Normal stoma (breathing pore) of potato leaf; *b*, *b*, similar stomata through which the germ tubes have entered the interior of the leaf; *c*, germ tube penetrating outer wall of an epidermal cell. Spores from culture on prune-agar, examined and drawn five days after placing on potato leaf. Magnified 280 diameters.

Fig. 3. Spores of *Macrosporium Solani, E. & M.* showing peculiar forms. Magnified 140 diameters.

Fig. 4. Spores of the saprophytic *Alternaria* occurring on potato leaves, three mature and three immature. Central one germinating. Magnified 280 diameters.

Fig. 5. Fruiting branch of this *Alternaria* from culture on prune-agar. Magnified 280 diameters.

Fig. 6. Similar branches of this *Alternaria*. Magnified 140 diameters.

PLATE II.

Fig. 7. Young colony of the *Alternaria* from potato leaf grown five days on prune-agar. Many spores were sown in the same dish and as a result early and profuse sporulation followed.

Fig. 8. Young colony of *Macrosporium Solani, E. & M.* from potato leaf grown in same dish with the *Alternaria* of Fig. 7.

4. POTATO LEAF BLIGHTS IN OTHER STATES.

While engaged in these studies during the summer of the past year a visit to the Mississippi valley afforded an opportunity to observe the condition of the potato plants in several localities. A great amount of "blighting" of potato leaves was evident in certain sections which were suffering severely from drought but examinations at several points along the route showed a very general absence of the typical *Macrosporium* trouble. Wishing to carry the studies further, officers of various experiment stations were asked in September to send such material as they could showing the *Macrosporium* or similar "blight" of potato leaves as it had occurred in the vicinity. Owing to the hearty responses received material was secured from eleven states. This was carefully examined by Mr. C. C. Tracy and following conditions found:

Station from which sent.	Early Blight (*Macrosporium Solani.*)	Tip-Burn.	The Saprophytic *Alternaria.*	Remarks.
Connecticut (Storrs) ...	**None......**	**Abundant...**	**Abundant...**	**Macrosporium plenty here in 1894.**
Delaware...	**Abundant.**	" ...	" ...	
Indiana.....	**None......**	"	" ...	
Mass.	"	" ...	**Some found.**	**Macrosporium plenty here in 1894.**
Michigan...	**Some .....**	"	**Abundant...**	
Geneva, N Y	**Abundant.**	"	" ..	**Badly eaten by flea beetles.**
Ithaca, N.Y.	**None......**	"	" ..	
N. Dakota..	**Some.....**	**None..........**	**None........**	....
New Jersey	**None** ...	**Considerable..**	**Considerable**	....
Ohio	**Abundant.**	" ..	"	....
Rhode Isl'd	" .	**Some. ....**	**Some........**	....
Wisconsin .	**None......**	**Abundant....**	**Abundant...**	....

The late (*Phytophthora*) blight was found only in connection with the specimen from Rhode Island.

Since much of this material was collected about September 1st, it would not necessarily represent the conditions which existed earlier in the summer, yet the presumption is that it does so in general. If this is true it indicates that the *Macrosporium* was either less generally prevalent than usual last summer or else that the injury due to it has been much over estimated.

II. BORDEAUX MIXTURE.

I. METHODS OF PREPARING BORDEAUX MIXTURE*.

Everyone experienced in preparing bordeaux mixture has observed the wide differences in the mixture as made in different ways. These differences are shown by the varying color of the mixture, and by the greater or less speed with which the blue precipitate settles upon standing. The ideal color is a deep blue, with no greenish tint, and the most desirable mixture is the one in which the precipitate settles most slowly. There has been some uncertainity as to the best manner of obtaining these results, however, which uncertainty has been increased since the introduction of the use of the potassium ferro-cyanide test.

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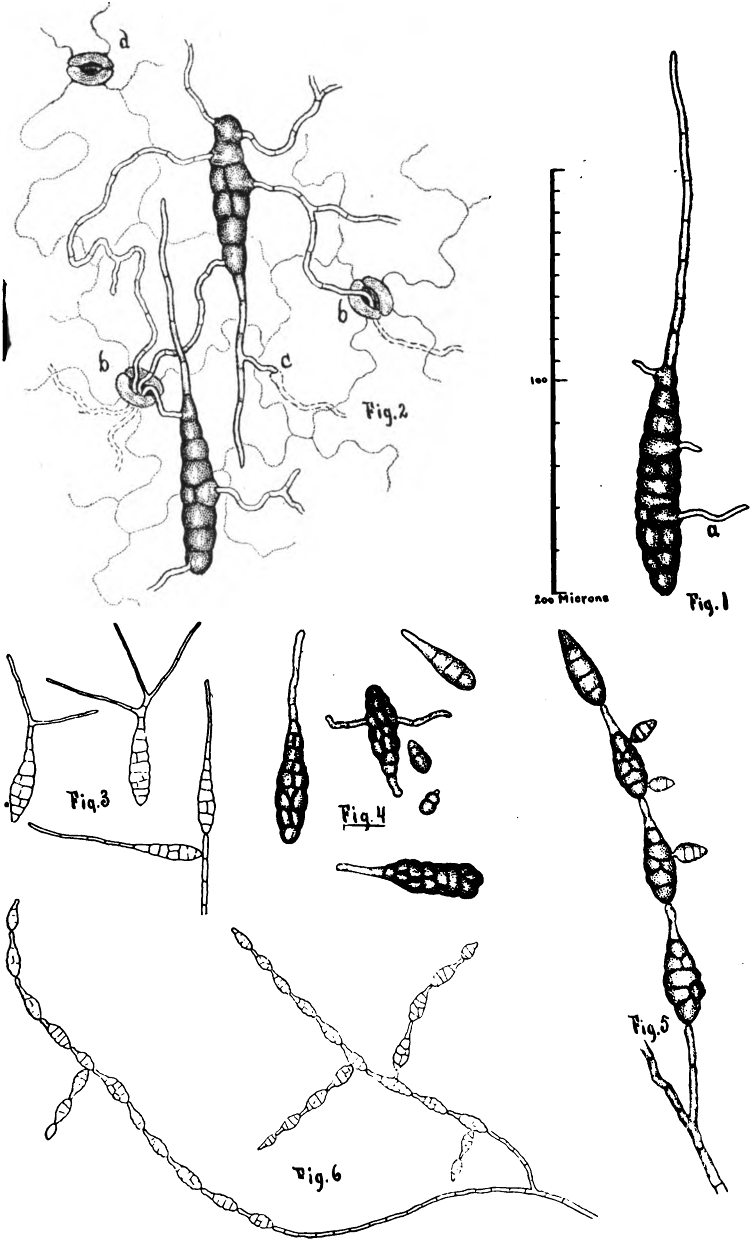
*This work was carried out by Mr. W. A. Orton, a student in the agricultural department of the University.

VERMONT AGRICULTURAL EXPERIMENT STATION.

NINTH REPORT, PLATE I.



POTATO LEAF FUNGI.

VERMONT AGRICULTURAL EXPERIMENT STATION.

NINTH REPORT, PLATE II.

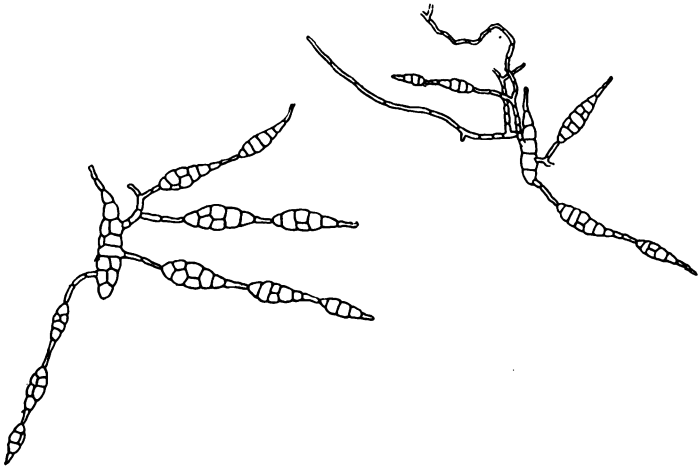


Fig. 7. The Alternaria from Potato Leaf grown in Prune-agar.

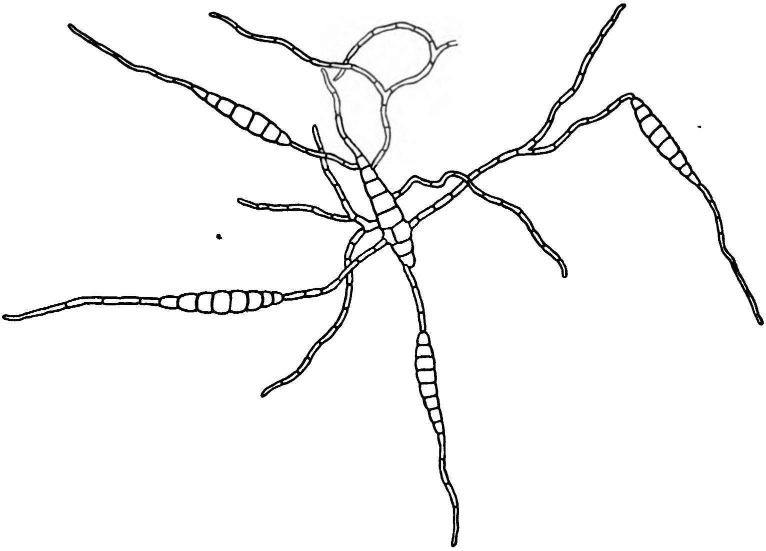


Fig. 8. Macrosporium Solani E. & M. from Potato Leaf grown in Prune-agar.

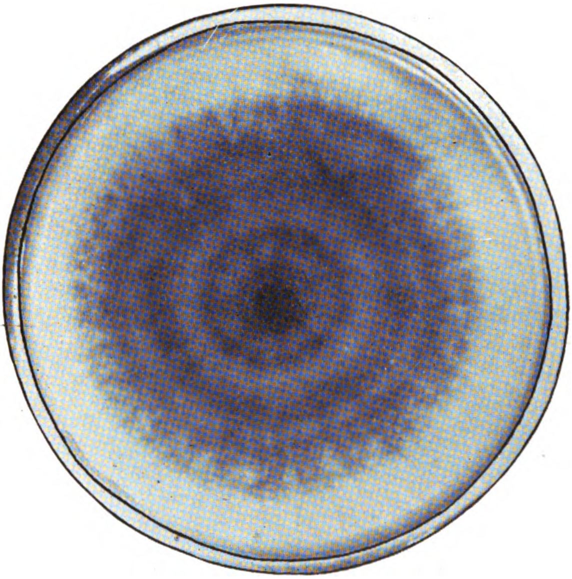


Fig. 9. Culture Dish, showing the Alternaria growing on Prune-agar.

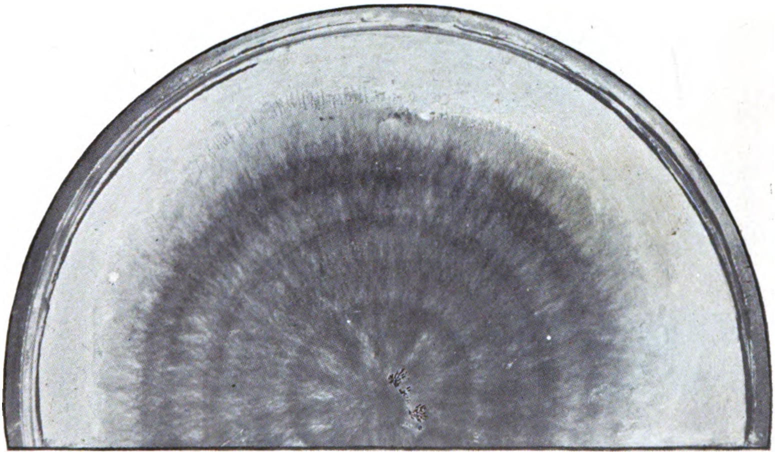


Fig. 10. Culture Dish (one-half), showing Macrosporium Solani E. & M. growing on Prune-agar.

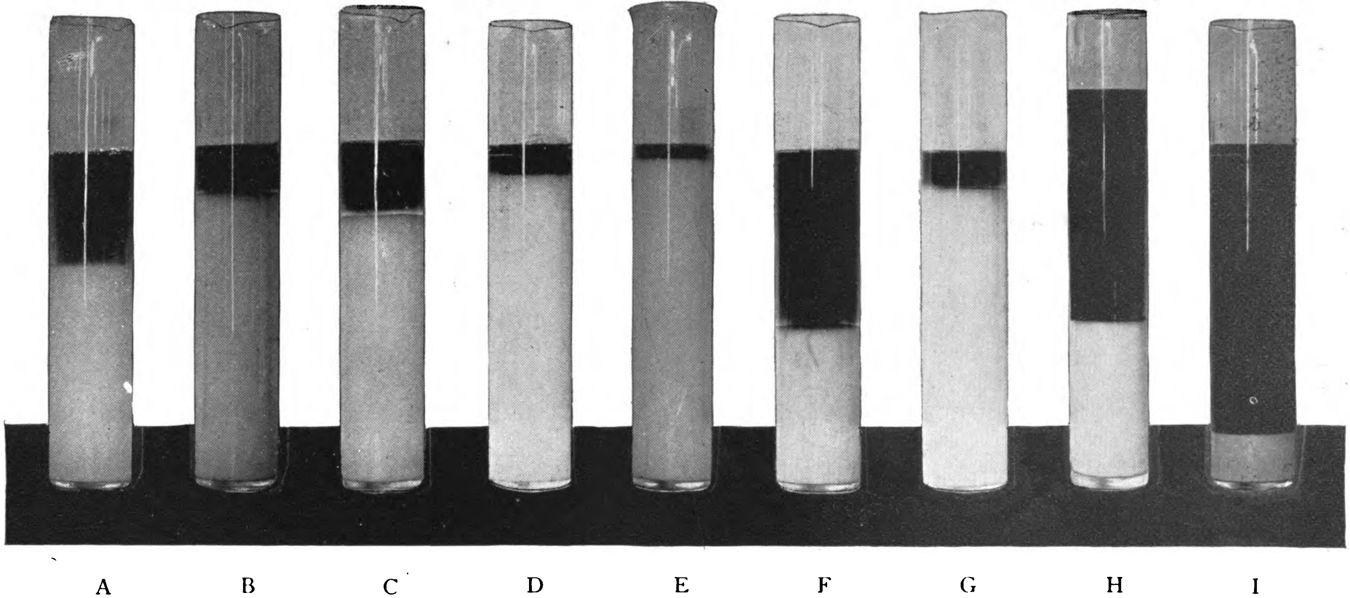


Figure 11. Jars showing relative rapidity of settling of the precipitate in Bordeaux Mixture made in various ways. Each jar stood one hour after making before photographed. The dark portion in each jar was clear water (colored with ink so as to show distinctly); the lighter portion below was the precipitate.

A. Mixture made by pouring dilute lime into dilute sulphate slowly.
B. Mixture made by pouring dilute sulphate into dilute lime slowly.
C. Mixture made properly (as E.) but using hot lime milk.
D. Mixture made as in E., but less thoroughly stirred.
E. Properly made Bordeaux mixture, *i. e.* from cold dilute solutions, quickly united and thoroughly stirred.
F. Made same as E. but using concentrated solutions.
G. Properly made mixture, one day old.
H. Old or "Stock" Bordeaux mixture, made two weeks before.
I. "Bordeaux Powder" mixed with water.

The recent studies of Mr. Swingle,* most of which have come to our hands since our own work was completed, have done much to clear up the obscurity as to the best methods of preparing the mixture, and so far as our work covers the same ground the results are in accord with those previously obtained by Mr. Swingle.

In order to observe more clearly the character and behavior of the mixtures made in the various ways under trial graduated glass cylinders† were used as vessels to contain them, thus enabling detection of very slight differences in color and also in the rate at which the precipitate settled The character of these vessels is shown in Plate IV.

Unless otherwise stated all mixtures were made with cold solutions in the proportion of one and one-half pounds of copper sulphate and one pound of lime to ten gallons of water.‡

The principal object in view in making the experiments was to learn how well the precipitate would remain in suspension when made in various ways, hence the rapidity of the settling of this precipitate is the chief thing considered in each case.

In order to make the discussion of the results clearer the method found upon trial to produce the best mixture will be described first. It will be seen that this method consists in the *rapid union of cold dilute solutions in such manner as to have at no time any excess of free copper sulphate*,

Such a mixture will be spoken of as "standard" mixture and used as a basis of comparison. The results obtained from other ways of combining the ingredients in comparison with this "standard," will then be discussed in the following order:

Mixtures made with insufficient stirring.
Mixtures made from *concentrated solutions*.
A mixture made with *hot* lime milk.§
A mixture made with "stock" lime milk.
A mixture made by the potassium ferro-cyanide test.
Old mixtures.
"Bordeaux powder" in water.

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*Rural New Yorker, September 28, 1895; U. S. Dept. Agric., Farmer's Bul. No. 38.

†At first cylinders of 500 c. c. capacity were used, later smaller ones (50 c. c.) were substituted as more convenient. The precipitate settles more rapidly in proportion to the total height of liquid in the smaller cylinders. Thus, a mixture that settled five per cent. of the height of the column in the taller, 500 c. c., cylinder settled about eight per cent of the height of the column in the 50 c. c. cylinder.

‡A stock solution of copper sulphate was used, which contained 450 g. to 4000 c. c. of water, or approximately one pound per gallon. Freshly slacked lime was used in most cases, 28 g. lime in 950 c. c. water (about one pound in two gallons). To make 50 c. c. of the mixture there were used 8.5 c. c. of the copper sulphate solution, 10 c. c. of the lime milk and 31.5 c. c. water.

§The lime milk is, properly speaking, a mixture rather than a solution. In order to avoid confusion, however, it is frequently spoken of as a solution, the term mixture in the discussion being applied only to the product of the union of the copper sulphate and lime, viz.: the bordeaux mixture.

HOW THE BEST OR STANDARD BORDEAUX MIXTURE WAS PREPARED.

The process best adapted to field work will be discussed later. (Page 92.) In these laboratory tests the most convenient method and the one followed in this work was to dilute both the copper sulphate solution and the lime milk with one-half of the total amount of water to be used and then pour the diluted lime milk *quickly* into the sulphate solution, following immediately by ***thorough mixing***, this mixing being best done by pouring the mixture several times from one vessel into another. Made thus we obtained a mixture of which a four-inch column ***after standing one hour settled less than one-sixth of an inch** or **four per cent.****

Equally good results were obtained when the diluted sulphate solution was quickly poured into the diluted lime milk and the combination immediately and thoroughly stirred.

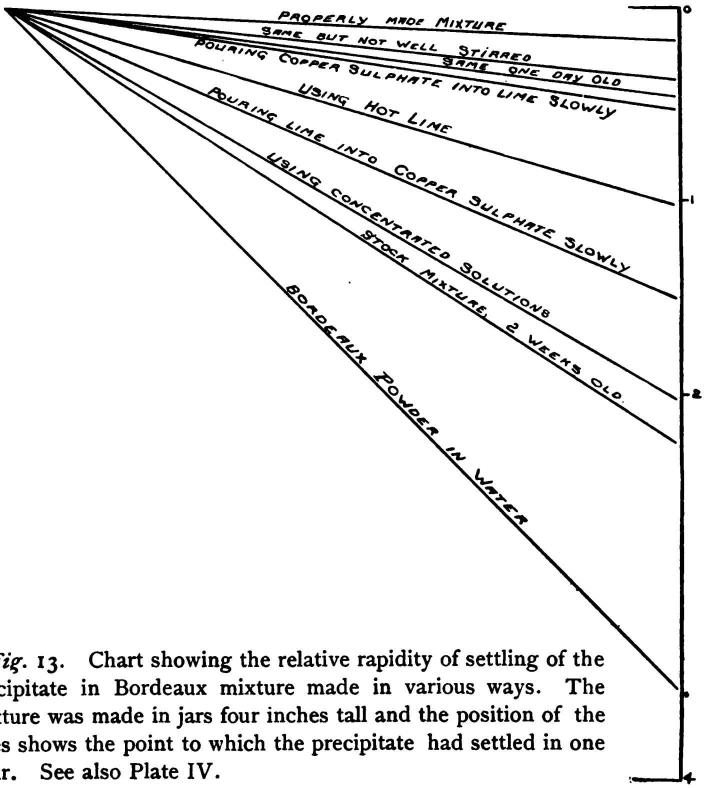

Fig. 13. Chart showing the relative rapidity of settling of the precipitate in Bordeaux mixture made in various ways. The mixture was made in jars four inches tall and the position of the lines shows the point to which the precipitate had settled in one hour. See also Plate IV.

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[*] **I. e., the blue precipitate had settled to leave only one-sixth of an inch clear water at the top.**

As contrasted with the "standard" mixture more or less inferior mixtures were obtained when the process was varied in the following ways:

METHOD OF MAKING THE MIXTURES.	Per cent of the entire depth to which the precipitate settled in	
	30 minutes.	one hour.
1. "*Standard*" *mixture*	....	*4 per cent*
2. Same but less thoroughly stirred	4 per cent	8 per cent
3. Dilute sulphate *slowly* added to dilute lime. No stirring while adding, thorough stirring afterwards	7 per cent	13 per cent
4. Dilute solutions poured together into a third vessel. No stirring while adding, thorough stirring afterwards	7 per cent	13 per cent
5. Concentrated lime milk added to concentrated sulphate and the mixture diluted	44 per cent	52 per cent
6. Concentrated lime added to diluted sulphate	....	15 per cent
7. Concentrated sulphate solution added to dilute lime milk	....	13 per cent
8. Lime milk at boiling heat added to sulphate	16 per cent	26 per cent
9. Lime slacked two months previously, kept under water. Mixture properly made was of standard quality	....	4 per cent
10. Made by potassium ferro-cyanide test, i. e. lime milk added to sulphate in successive small amounts until solution failed to respond to the test	50 per cent	....
11. Mixture made using same quality of lime as in 10, but adding suddenly with prompt stirring	....	4 per cent
12. "Standard" mixture 24 hours old	....	10 per cent
13. "Standard" mixtures two weeks old	....	56 per cent
14. "Bordeaux Powder" in water	85 per cent	....

IMPORTANCE OF GOOD LIME, PROPERLY SLACKED.

The quality of the lime and the method of slacking it have much influence upon the mixture. Thus other conditions being equal a mixture made from a poorly slacked lime settled nineteen per cent. in an hour, while a mixture made from a properly slacked lime settled only eight per cent. during the same time. Lime that had been partially air slacked gave still poorer results. The lime should be fresh, clean and firm. In slacking the best results were obtained by adding at first only a small amount of water, preferably hot, and then, as slacking begins, adding cold water in small amounts as needed, never adding much at a time nor ever allowing the lime to become dry. When too much water is added small lumps of lime are apt to be covered and remain unslacked. When the lime is fully slacked it should be diluted by adding water slowly while stirring.

Summary and Conclusions.

Properly made bordeaux mixture should be of a peculiar deep blue color and should settle very slowly. The lime properly slacked may be kept as "stock" if covered with water, and such stock lime is preferable to poorly kept or partially air slacked lime. Copper sulphate may be also conveniently dissolved in large quantities and kept as a "stock solution" to be drawn upon as needed. The best results are most surely obtained if such stock lime and sulphate solutions are much diluted before combining.

The details of their combination are also important. The more quickly and thoroughly they can be mixed the better the result, and especial care should be taken that at *no time is there an excess of free copper sulphate in any part of the mixture.* Bearing this last injunction in mind equally good results may be obtained in several ways.

1. By pouring the dilute lime milk into dilute sulphate solution very quickly and then stirring thoroughly.

2. By pouring the dilute sulphate solution quickly into the dilute lime milk, then stirring thoroughly.

3. By pouring the dilute sulphate solution slowly into the dilute lime milk and thoroughly stirring while adding.

4. By pouring the two together into a third vessel so that the two streams meet, stirring meanwhile until thoroughly mixed.

In all cases thorough and long continued stirring improves the mixture.

In ordinary practice it is not practicable to obtain the best results by pouring the lime into the sulphate. (No. 1 above.) The best method to follow then is either to pour the two dilute solutions together carefully while stirring, or to pour the diluted sulphate into the diluted lime, stirring meanwhile. In this dilution it may be inconvenient to dilute the sulphate solution with one-half the total amount of water, in which case two-thirds of the water may be added to the lime and only one-third to the sulphate with good results, but the sulphate should not be more concentrated than this. If obliged to add the lime *slowly*, it is found that adding concentrated lime slowly to dilute sulphate gives better results than adding dilute lime slowly to the dilute sulphate.

Hot lime milk gives an inferior mixture, but a slight degree of warmth is not injurious. In practice diluting the freshly slacked lime with cold water will cool it sufficiently.

The smaller amount of lime needed to satisfy the potassium ferro-cyanide test gives a mixture of standard quality, so far as its physical properties are concerned at least, providing the ingredients are combined properly, i. e., quickly with thorough stirring. As usually made, however, it is distinctly inferior. Its physical qualities are rapidly impaired, hence so far as possible it should be made up fresh as needed. Where old mixture is used greater pains than usual should be taken to keep it thoroughly stirred during use.

2. A FIELD TEST OF VARIOUS FORMS OF BORDEAUX MIXTURE ON POTATOES.

Our experience last summer served to strengthen our previous conviction on the following points:

First, that it pays to protect both early and late potatoes in Vermont with fungicides as well as insecticides.

Second, that no other fungicide yet devised is at all equal to bordeaux mixture for use on potatoes.

There are, however, various forms of bordeaux mixture concerning the relative values of which we are frequently questioned. Experiments made at this station and elsewhere have shown that the bordeaux mixture of medium strength, and freshly prepared as used, is superior to any other form for practical use on potatoes. The studies of the previous article serve to emphasize and explain in part the reason for this. Certain other forms of the mixture are, however, more conveniently made or applied, and the question arises whether the advantages thus offered will not out-weigh the loss in quality of the mixture. We are often asked for example, whether it will not do as well to make up in concentrated form as much mixture as will be needed for the season, and take from this "stock" mixture and dilute as needed for use. The question also is raised, whether when through spraying the residue of the mixture should be kept and used in the next application or whether it should be thrown away.

The use of the dry powder guns for applying paris green is meeting so much favor that many have asked whether bordeaux mixture could not be prepared in the form of dry powder and applied with these guns in the same way as is done with paris green.

In order to have experimental evidence upon these points one-half acre of potatoes was set aside in 1895 for a test of the comparative values of the following forms of bordeaux mixture:

1. "*Standard*" *Bordeaux Mixture*, freshly made as used. Ingredients: 1½ pounds of copper sulphate, 1 pound of lime, 10 gallons of water. This is the mixture we have been recommending for practical use for the past year.

2. "*Test*" *Bordeaux Mixture*, freshly made as used. Ingredients, the same amounts of copper sulphate and water as in the standard mixture, (No. 1), but only enough lime added to neutralize the copper sulphate, as shown by testing with a solution of ferro-cyanide of potassium.

It has been our experience in preparing the mixture by this test that only about one-half as much lime is needed as is used in the standard mixture, that is to say, this "test" mixture actually contained in each ten gallons of water, 1½ pounds of copper sulphate and about one-half pound of lime.

3. "*Stock*" *Bordeaux Mixture*, prepared at the beginning of the spraying season in July. This was made in the same way as the standard mixture except that only one-half as much water was used. This stock mixture was allowed to stand in open vessels during the summer. At the time of each application it was thoroughly stirred and from it as much as wished for immediate use was dipped out and diluted with equal parts of water so as to make it of the same strength as the standard mixture.

4. "*Bordeaux Powder*." This was prepared by making standard bordeaux mixture as in No. 1, which was then allowed to stand until the blue precipitate had settled. The clear water was then poured off the top, the blue precipitate thoroughly dried and then ground between millstones to the finest possible powder. The powder was applied in the following ways:

(*a*). Dry and undiluted.

(*b*). Dry, after dilution with wheat flour in proportion of 1 part of powder to 3 parts flour.

(*c*). With the spray pump after mixing with water in the proportion of 1 pound of the powder to 4 gallons of water. This mixture of the powder in water exactly equals in chemical strength the "standard" bordeaux mixture (No. 1, above).

5. "*Fungiroid*." A powder similar to the above, prepared and sold as a fungicide by Leggett and Brother of New York City. This was applied in the following ways:

(*a*). Dry and undiluted.

(*b*). Dry after dilution in the proportion of one part of the Fungiroid to three parts flour.

The field was planted May 20th with four varieties of potatoes, viz.: Beauty of Hebron,* Rural New Yorker No. 2, White Star and Polaris. These variety plots extended in rows running north and south. The plots were staked for experimental spraying crosswise of these rows so that each sprayed plot included all four varieties. As laid out in this way there were fifty-one rows to be used in the test. Each third row of these was left untreated as a "check," while the remaining rows were treated with the various fungicides under test as shown in the following page.

The liquid mixtures were applied with a knapsack spray pump at the rate of about 125 gallons per acre in the first applications, and as the plants increased in size the amount was increased to about 200 gallons per acre in the third.

The amount of dry powders used was made to agree as nearly as practicable with this, being applied at the rate of about 40 pounds per acre, using for the purpose a Leggett powder gun. Forty pounds of the dry bor-

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*** Owing to the poor "seed" the stand of Hebron potatoes was so irregular that the yields are not given.**

deaux powder contains the same amount of copper sulphate and lime as 160 gallons of the standard bordeaux mixture.

A glance at the following page will show that the check rows and those sprayed with the standard bordeaux mixture were so scattered across the field as to give an opportunity to use both for close comparison in determining the relative value of each of the other methods of treatment. The idea governing this plan was that this bordeaux mixture would serve as the highest standard of excellence and that the "check" rows would represent the lowest limit. The results showed this presumption to be correct. The potatoes were purposely planted late in order to avoid complications with the various insect and early blight attacks of July. Three applications of each fungicide were made; the dates of applications being as follows: first, July 25th; second, August 13th; third, August 31st.

The late or Phytophthora blight was later than usual in appearing, the first indication of its presence being detected about September 1st. From this date until the last of the vines were killed by frost, about October 10th, this disease continued its depredations, the check rows being all killed off by the middle of September, and the others dying in the order indicated below. October 1st, before a killing frost came, a critical examination of the field was made and from the appearance of the tops alone the various fungicides were graded in the following order as to relative value:

First, "Standard" Bordeaux mixture; in excellent condition.

Second, "Test" Bordeaux mixture; distinctly inferior to rows sprayed with the standard mixture, although looking very well.

Third, "Stock" Bordeaux mixture; very uneven in appearance, some in fairly good condition, others entirely dead.

Fourth, "Bordeaux powder" applied in water; very uneven, some fairly good, others dead.

Fifth, "Bordeaux powder" and "Fungiroid" applied undiluted as dry powders; these gave about equally poor results, the plants in both cases being nearly dead.

Sixth, "Bordeaux powder" and "Fungiroid" diluted with flour and applied dry; plants were entirely dead and the rows indistinguishable from the "check" or untreated rows.

The results upon digging were even more convincing than the appearance of the vines. Owing to the continued progress of the disease for some weeks after the last spraying was done, there was considerable loss from the rot even where the bordeaux mixture was used. Another application of this mixture in September would have prevented much of this and would have been very profitable. Since some of the plants treated with weaker

PLAN OF POTATO FIELD SPRAYED EXPERIMENTALLY.

ROW NO.		Yield of tubers of marketable size in lbs.	
		SOUND.	ROTTEN.
141	Sprayed with "Standard" Bordeaux Mixtures	185.	11.8
142	Check, i. e., no fungicides applied	111.	27.8
143	"Standard" Bordeaux mixture	159.7	14.7
144	"Test" Bordeaux mixture (No. 2,)	159.7	9.3
145	Check, no fungicide	118.7	61.6
146	"Standard" Bordeaux mixture	157.4	20.5
147	"Stock" Bordeaux mixture	141.4	30.7
148	Check, no fungicide (No. 3,)	110.4	43.7
149	"Standard" Bordeaux mixture	156.0	19.9
150	Bordeaux powder, dry, undiluted (No. 4 a,)	85.	69.3
151	Check, no fungicide	52.9	55.2
152	Bord. powder, dry, diluted with flour (No.4 b,)	60.4	70.
153	Fungiroid, dry, diluted with flour (No. 5 b,)	56.8	78.5
154	Check, no fungicide	59.4	78.7
155	Bordeaux powder, dry, undiluted	74.5	84.2
156	Fungiroid, dry, undiluted	87.8	53.2
157	Check, no fungicide	88.9	59.2
158	"Standard" Bordeaux mixture	142.3	33.2
159	Bordeaux powder in water (No. 4 c,)	151.1	31.
160	Check, no fungicide	50.1	70.
161	"Standard" Bordeaux mixture	127.4	32.4
162	"Test" Bordeaux mixture	120.5	21.9
163	Check, no fungicide	84.1	84.4
164	"Standard" Bordeaux mixture	145.5	25.5
165	"Stock" Bordeaux mixture	100.3	53.
166	Check, no fungicide	61.5	86.8
167	"Standard" Bordeaux mixture	141.9	34.9
168	Bordeaux powder, dry, undiluted	100.1	70.4
169	Check, no fungicide	62.9	71.3
170	Bordeaux powder, dry, diluted with flour	76.1	83.1
171	Fungiroid, dry, diluted with flour	67.7	71.6
172	Check, no fungicide	76.4	80.3
173	Bordeaux powder, dry, undiluted	71.8	70.4
174	Fungiroid, dry, undiluted	77.3	66.2
175	Check, no fungicide	83.8	55.3
176	"Standard" Bordeaux mixture	146.7	32.1
177	Bordeaux powder in water	124.5	83.3
178	Check, no fungicide	58,1	97.6
179	"Standard" Bordeaux mixture	158.	34.9
180	Bordeaux powder, dry, undiluted	109.7	56.1
181	Check, no fungicide	94.5	71.
182	Fungiroid, dry, undiluted	72.	74.
183	"Test" Bordeaux mixture	109.3	48.
184	Check, no fungicide	102.1	46.3
185	"Standard" Bordeaux mixture	142.5	27.3
186	Bordeaux powder, dry, undiluted	94.4	59.3
187	Check, no fungicide	91.1	47.5
188	Fungiroid, dry, undiluted	92.9	40.4
189	"Test" Bordeaux mixture	132.2	37.9
190	Check, no fungicide	80.	67.1
191	"Standard" Bordeaux mixture	241.7	27.2

fungicides were already dead it was impracticable to make a uniform application to all and therefore none were sprayed after September 1st.

The yields of both sound and rotten tubers are given for each row on the preceding page. A glance at these will show that there was a considerable difference in soil conditions between the two ends of the field. This was known when the experiment was planned and the frequent insertion of both check rows and those sprayed with standard Bordeaux mixture was made in order to meet this difficulty.

In order to judge of the relative value of any treatment it is easily compared with these rows lying near it on either side. After a careful study of the results the following table has been made as representing fairly the relative protection afforded by the various fungicides named. The yields are translated into bushels per acre in order to make them more intelligible to the average reader.

TABLE SHOWING RELATIVE PROTECTION FROM USE OF VARIOUS FUNGICIDES.

TREATMENT.	AVERAGES TAKEN FROM ROWS.	YIELDS IN BUSHELS PER ACRE.	
		LARGE SOUND TUBERS.	LARGE ROTTEN TUBERS.
Standard Bordeaux mixture	143, 146, 161, 164, 179, 185	389.	67.
"Test" Bordeaux mixture	144, 162, 189, 189	349.	78.
"Stock" Bordeaux mixture	147, 165	322.	112.
Bordeaux powder, dry, undiluted	158, 155, 168, 173, 180, 186	235.	182.
Fungiroid, dry, undiluted	156, 174, 182, 188	220.	156.
Check, no fungicide	average of all	219.	168.

Conclusions. With these figures before us there can be no hesitation in drawing the following conclusions:

Standard Bordeaux Mixture (1½ lbs. copper, 1 lb. lime, 10 gals. water,) *freshly prepared as used* is so distinctly superior to all others that it alone should be used.

"*Test*" *Bordeaux Mixture* (1½ lbs. copper sulphate, 10 gals. water, lime added by potassium ferro-cyanide test [about ½ lb. lime used]) was not equal to the standard mixture.

"*Stock*" *Mixture*, or old mixture, is so distinctly inferior to the others that its use should be avoided so far as practicable, i. e., one should always aim to make up no more of the mixture than is to be used immediately.

Bordeaux Powders. The last remarks apply equally to the bordeaux powder where it was applied in water with the spray pump.

When these powders were applied dry even in most liberal amounts they gave so little protection that their substitution for the ordinary or wet mixture is not to be recommended under any circumstances.

The powders as diluted with flour were much inferior to the undiluted powders.

III. DISINFECTION OF SEED POTATOES.

The following experiments were undertaken to gain more definite information upon two points:

First, The condition of the resulting crops when seed potatoes disinfected by the corrosive sublimate bath are planted on infected soil as compared with similar seed on clean soil.

Second, The effect of the disinfection upon "germination" and yield.

Three series of plots were planted with similar seed, in each of which a portion of the seed was disinfected and a duplicate portion not disinfected.

Series One was planted on *clean* soil, the disinfected seed widely separated from the infected in order to test the efficacy of the disinfection under proper conditions.

Series Two was planted on old *infected* soil, the disinfected seed and that not disinfected being well separated from each other in order to determine the effect of disinfection where the crop is grown upon old soil. The effect of the treatment upon "germination" and yield was also observed.

Series Three was planted on similar soil to that used in series two but disinfected and untreated seed were used in *alternate rows* in order to more closely compare the results of treatment on "germination" and yield.

Disinfection was performed in all cases by freeing the potatoes from dirt by washing, followed by immersion for one and one-half hours in a solution of 2 1-4 ounces of corrosive sublimate in 15 gallons of water.

SERIES ONE.

The seed designated as "scabby" in the following account was as bad as was obtainable, the condition in some cases rendering good "germination" doubtful. The soil used for this series was unquestionably perfectly free from germs of the scab. It was nearly a mile from any house and had recently been covered with pine forest. No crop had been planted since the removal of the pines.

The various lots of potatoes were scattered so as to preclude danger of germs being carried from infected to disinfected plots in soil water. But little cultivation was given the plants and that little was with the hoe which lessened the chance of carrying germs from plot to plot as compared with horse cultivation.

The conditions of the seed and of the resulting crop were as follows:

No. of row	VARIETY.	CONDITION OF SEED.	TREATMENT OF SEED.	PER CENT. OF SCABBY TUBERS.
1	Polaris	Scabby:......	None.........	33
2	"	"	Disinfected ..	7
3	White Star..	"	None	22
4	" " ..	"	Disinfected ..	.......None
5	Unknown....	Very Scabby.	None.........	57
6	"	" "	Disinfected ..	12
7	New Green...	Smooth.....	" ..	........None
8	E'rly Worther	"	" ..	........None
9	B'ty Hebron.	"	None.........	5
10	Snowflake ...	"	"	20

The results show clearly that disinfection of very scabby seed even after careful cleaning did not insure a perfectly clean crop even on a virgin soil, (rows 2 and 6.) The reduction in amount of scab in all such cases is very great, however (rows 1, 3 and 5), the average amount of scab in the crop from such untreated seed being 37 per cent. while in the corresponding rows from disinfected seed the amount of scab is reduced to 6 per cent. The results further show that where smooth seed was used after disinfection a perfectly clean crop was secured (rows 7 and 8.) Where, however, smooth seed was used without disinfection more or less scab resulted. (rows 9 and 10.) Although rows 9 and 10 were not of the same varieties as 7 and 8 there is no reason to suspect that the results would have been different had these varieties been used.

SERIES TWO.

This was designed to test the effect of the disinfection of the seed potatoes upon their "germination" and upon the condition of the resulting crop, both as to scabbiness and yield, when planted upon *infected* soil. The soil had been in grass for some years prior to 1894, when it was thoroughly manured and planted to tomatoes. Adjoining land planted that year to potatoes had produced a somewhat scabby crop from clean seed, indicating an infected soil.

The details as to conditions and results are shown in the following tables:

SMOOTH SEED USED.

VARIETY.	PER CENT OF SCABBY TUBERS.	
	UNTREATED.	DISINFECTED.
Rural New Yorker	11.5	3
Early Puritan	55	21
Polaris	37.5	17
White Star	10	10
Averages	28.5	12.8

SCABBY SEED USED.

VARIETY.	PER CENT OF SCABBY TUBERS.	
	UNTREATED.	DISINFECTED.
Rural New Yorker	34	15
Early Puritan	50	5
Polaris	49.5	18
White Star	28	24
Unknown	66	20
Averages	40.4	15.5

The plots were planted May 25. On June 11 it was noted that "the germination of the disinfected potatoes is plainly retarded in all cases. Those disinfected are now just breaking through the soil while the plants in the adjoining rows not disinfected are three and four inches high."

The effect of disinfection of seed upon scabbiness is evidenced by the figures in the above tables. In all cases there is a decided reduction in the amount of scab found in the resulting crop, this reduction being on the average, where smooth seed was used, from about 28 per cent. to 12 per cent., and where scabby seed was used from 40 per cent. to 15 per cent.

In no case was there perfect freedom from scab, nor was this to be expected owing to the infected condition of the soil. There was no effect upon yield from the treatment that is worthy of note.* The total yield of large tubers from the disinfected and from the corresponding untreated rows averaging as following:

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* Our results last year (Vt. Exp. Sta. Rep. 1894, p. 106) indicated a considerable gain from the disinfection of scabby seed. It is possible that this larger gain in 1894 was due to the fact that the seed then used was more badly diseased than that used in 1895.

Yield of rows, untreated seed, 1507 tubers weighing 763 pounds.

Yield of rows, disinfected seed, 1417 tubers weighing 789 pounds.

SERIES THREE.

This was designed to test the effect of the disinfecting upon "germination" and yield, the disinfected and untreated seed being planted in alternate rows so as to allow closer comparison than was possible in the more isolated plots of series two. It was to be expected that this proximity would lessen the gain from the disinfection so far as concerns scabbiness of the resulting crop, and also that it might interfere with a possible gain in yield from the disinfection. The results fully bear out the first expectation, at least, as shown in the following summary of results. All seed tubers used in this series were free from scab spots.

VARIETY.	TREATMENT OF SEED.	TUBERS FREE FROM SCAB.	TUBERS SCABBY	TOTAL.
Houlton Rose....	Untreated.	189	137	326
" "	Disinfected.	271	60	331
Extra Early Vt...	Untreated.	117	17	134
" "	Disinfected.	118	38	156
White Star......	Untreated.	338	68	406
" "	Disinfected.	384	48	432

The totals from this table are as follows, with the addition of total weights:

Untreated, 866 tubers, weighing 203 pounds; 644 smooth, 222 scabby.

Disinfected, 919 tubers, weighing 193 pounds; 773 smooth, 146 scabby.

The disinfected seed tubers were slow in starting growth as in the case of series two. The yield from the untreated seed tubers is slightly greater than from the disinfected tubers, but the difference is not great enough to be noteworthy. The condition as regards scab is in line with the results from series two but has little experimental significance owing to the proximity of the rows planted with treated and untreated seed.

GENERAL SUMMARY OF RESULTS FROM DISINFECTION EXPERIMENTS.

First. Smooth seed, but taken from a crop having more or less of scab, when planted on clean soil, gave a somewhat scabby crop, although much less so than did scabby seed.

Second. Smooth seed, disinfected and planted on clean soil gave a perfectly clean crop.

Third. Very scabby seed washed and disinfected in the same way gave a crop slightly scabby, but very much less so than did similar untreated seed.

Fourth. Smooth seed, disinfected, planted on infected soil produced a crop considerably cleaner than untreated seed, but in no case was it entirely free from scab.

Fifth. Disinfection of the seed performed just prior to planting in all cases retarded the "germination" and apparently weakened the young plants.

Sixth. There was no apparent gain or loss in total yield, large enough to be significant, attributable to disinfection of seed.

In view of the fifth conclusion stated above, it would seem probable that the soaking of the seed tuber in the corrosive sublimate solution just before planting injures or at least retards the starting of the young sprouts. It is probable that this is due to the injurious action of the poison on these sprouts, and that the more advanced sprouts are more liable to injury than those in a more dormant condition. If this is the correct explanation it follows that the disinfection should be performed earlier, either the previous fall or during the winter, instead of being delayed until just before planting time, as is the usual practice. The earlier disinfection will prevent scab equally well, provided care is taken not to reinfect them in the subsequent stirring and handling of the seed potatoes. Such poisoned tubers should always be plainly labelled to prevent danger from their use as food.

IV. ORCHARD DISEASES AND REMEDIES.

I. SPRAYING PEARS WITH BORDEAUX MIXTURE.

In 1894 about 35 apple trees and 3 Flemish Beauty pear trees in the orchard of Miss Lydia M. Root, South Hero, were sprayed under our directions, and the results noted in our last annual report (page 109). The benefits from that work were so evident as to convince all who saw the crop of the value of the spraying. It is easily understood moreover that the thorough disinfection of a tree by such spraying should insure a more healthy crop for the succeeding season—thus the beneficial effects of spraying the tree should prove in a degree cumulative from year to year. In order to observe whether this occurs to an appreciable degree the same trees were sprayed in the same manner this season (1895), and it is planned to continue the work similarly in 1896. As 1895 was not the bearing year for apples it was not possible to judge of results upon these, but the Flemish Beauty pear trees bore well and showed marked improvement where sprayed, the fruit being even more perfect than in 1894.

The benefits resulting from the applications of 1894 were apparent before the work of 1895 began, all of the sprayed trees being easily recognized by the cleaner and brighter color of the bark on trunk and limbs. It was also noted that the buds on the sprayed trees started earlier and more vigorously. The trees were sprayed four or five times, as follows:

April 23, before buds opened; sprayed with solution of one pound of copper sulphate in 15 gallons of water.

May 10, leaves expanded; sprayed with bordeaux and paris green mixture.

May 30, petals just fallen; sprayed same as before.

June 12, sprayed same as before.

June 26, sprayed pear trees No. 1 and 2, as before, leaving pear No. 3 without further spraying.

Scab spots were found on the leaves and young fruit of the unsprayed trees at the date of the last spraying, but none on those of the sprayed trees.

The pears bore well and the fruit was gathered August 30. As before stated, there was so little fruit upon the apple trees that no attempt was made to judge its condition accurately, although there were evident benefits from the spraying.

The three Flemish Beauty pear trees which were sprayed bore eight barrels of fruit, which, together with two barrels borne by an adjoining unsprayed tree, was carefully sorted, with the following striking results:

FRUIT FROM TREES NO. 1 AND 2, SPRAYED FIVE TIMES.

1st	barrel,	547	pears,	first class;	25	second class.
2nd	"	626	"	"	1	"
3rd	"	676	"	"	2	"
4th	"	582	"	"	3	"
5th	"	643	"	"	7	"
6th	"	734	"	"	5	"
Total,		3808	"	"	43	"

The apparent cause for the inferior condition of the 43 pears sorted out as second class was as follows: 16 shrivelled by fire blight; 9 injured by limb bruises; 13 under size; 4 russeted, possibly by the mixture; *1 scabby.*

Tree No. 3, sprayed four times, showed the following condition of fruit:

1st	barrel,	614	pears,	1st class.	8	2nd class.
2nd	"	627	"	"	7	"
Total,		1241	"	"	15	"

Of these 15 second class pears, four were scabby, the other eleven being inferior because of small size or limb bruises.

In contrast with these results the following were found on the unsprayed tree:

1st	barrel,	618	pears,	1st class.	119	2nd class.
2nd	"	559	"	"	129	"

The second class fruit was only about half size and was badly scabbed and cracked.

The inferior condition of the fruit designated as "first class" from this tree as compared with that from the sprayed trees was also very striking, since all of the fruit from the unsprayed trees was more or less scabby, while that from the sprayed trees was entirely smooth.

In order to learn more exactly the effect of the scabby condition of the fruit upon its market value, a barrel of the "first class" fruit from each the sprayed and the unsprayed trees was shipped to the New York market, directed to L. S. Davis, a commission merchant, for his judgment. His reply was that the market was crowded with pears and prices very low, but that while the unsprayed fruit was worth $1.75, that from the sprayed tree was worth $2.25.

The results may then be briefly summarized as follows:

When the trees were sprayed nearly 99 per cent. of the fruit matured perfect and entirely free from scab, and only one scabby pear was found in the six barrels of fruit where the trees were sprayed five times, and but four scabby pears in two barrels of fruit where the tree was sprayed four times.

Practically every pear borne on the unsprayed trees was scabby, nearly 19 per cent. of the fruit was worthless for marketing, and the remaining 81 per cent. was decidedly inferior to that from the sprayed trees,

When placed on the New York market the sprayed fruit was valued at $2.25 as contrasted with $1.75 for the best of the unsprayed fruit. The relative values of the crops from the sprayed and unsprayed trees is then easily computed as follows:

A barrel of fruit from the unsprayed tree has 81 per cent. of marketable fruit, worth $1.75 per barrel. Value, .81 × $1.75=$1 42.

A barrel of fruit from the sprayed tree has 99 per cent. perfect fruit, worth $2.25 per barrel. Value, .99 × $2.25=$2 23.

The gain from spraying is then 81 cents on each barrel of fruit which is equivalent to $1.50 to $2.50 per tree as the crop ran in this orchard, a very profitable return for the four sprayings necessary to secure this result.

II. FROST INJURIES TO APPLES AND PEARS.

The following letter sent to the Experiment Station from Vergennes, Vt., under date of August 13, 1895, is typical of a number of inquiries received last summer and autumn:

"We send you to-day samples of apples showing a diseased condition which has attacked our fruit for the first time. We should like to learn if it is a new trouble and what can be done to prevent it. It has attacked all kinds of apples, but is worst on the Greenings. It starts as a small spot and spreads, often covering the entire apple, the growth being checked by it. It seems to be worse on the east side of the trees. The rapidity with which it has spread in the last ten days causes us to fear that it will injure the sale of the fruit. Can we do anything to stop it this year and how shall we check its return another year."

The skin of the apples received was badly russeted over the surface from one-third to one-half the distance back from the apex towards the stem. On some the russeted area formed a band or zone extending partially or entirely around the apple midway between apex and stem. The injury was even more common on the pears brought from about Burlington into the city markets than it was upon apples. The accompanying figures are photographs of injured Bartlett pears, showing the characteristic russet zones.

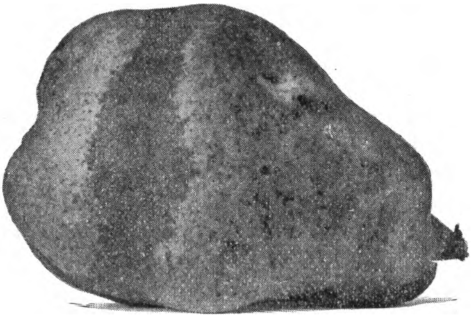

Fig. 14. A Bartlett pear showing frost band.

Many fruit growers attributed the russeting to injury from solutions used in spraying them, yet on inquiry it was found that unsprayed trees suffered equally with sprayed ones. The injury was unquestionably due to a late frost. Similar injury was observed by the writer upon fruit in Canada, New York State and as far west as Wisconsin.

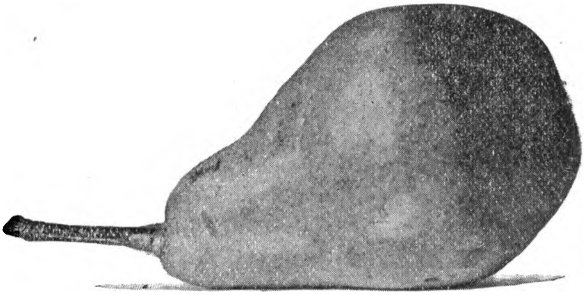

Fig. 15. A Bartlett pear showing frost injury at apex.

Mr. G. H. Powell, of Cornell University, writing in *Garden and Forest*, Vol. VIII, p. 417, regarding the trouble, says it is due to the freezing of the dew collected upon the young fruit, and Dr. Sturgis, of the New Haven, Conn., Experiment Station, in his Report for 1895, accepting this explanation, adds that the broadening of the injured zone later during the growing period of the fruit is due to continued rupturing and rehealing of the tissues adjacent to the injured area.

V. SOME OBSERVATIONS REGARDING OAT SMUT.

I. RELATIVE AMOUNTS OF SMUT IN OATS GROWN IN VERMONT AND IN MORE WESTERN STATES.

Determinations of the per cent. of smutty oat plants found in a large number of fields in Vermont during several years past have shown that as a rule the oat crop of Vermont is much freer from this disease than is that of most sections of the country. This difference is in especial contrast with the large amount of oat smut occurring in most of the Western States.*

As a result of our observations it was stated in the Report for 1893, p. 65, that the evidence from all sources points to the conclusion that "*certain conditions affecting the oat crop in Vermont are unfavorable to the development of smut as compared with the conditions of many, if not most, of other sections of the country.*"

Since the smuttiness of the crop is largely dependent upon the condition of the seed, the above conclusion, if correct, should lead Vermont farmers to avoid the use of Western oats of unknown origin for seed.

In order to learn more fully the facts regarding this difference in occurrence of smut and to collect other data which might help to explain the reason for such conditions, letters were sent to officers of various Experiment Stations asking them to co-operate by sending seed oats from their States, containing, if possible, a considerable per cent. of smut, and to sow some of the same at their own stations. Each was further asked to note the climatic conditions prevailing at his station during the period when the oats were germinating and when they were in flower.

Samples were received as follows:

South Dakota, sent by T. A. Williams, four samples.
Wyoming, sent by Aven Nelson, one sample.
Wisconsin, sent by E. S. Goff, one sample.
Michigan, sent by C. F. Wheeler, one sample.
Ohio, sent by A. D. Selby, five samples.
Illinois, sent by G. P. Glinton, one sample.
Iowa, sent by L. H. Pammel, one sample.
Indiana, sent by J. C. Arthur, two samples.
North Dakota, sent by H. L. Bolley, three samples.

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*The following is reprinted from our former Bulletin 32:

"The loss from oat smut in New York was estimated in 1885 at 10 per cent. of the entire crop; in Kansas, 1888–91, at 6 to 11 per cent.; in Indiana, 1891, at 10 per cent.; in Michigan, 1891, 15 per cent.; in Wisconsin, 1891, at fully 15 per cent. In view of these estimates the U. S. Department of Agriculture in a recent bulletin stated that the 'average loss is from 5 to 12 per cent. in different localities in the United States,' while another good authority, Dr. Arthur, states that this country loses annually from smut 'nearly or quite 10 per cent. of the total oat crop.'"

Our thanks are due these gentlemen for their co-operation.

The series of plats were sown at Burlington with some or all of these samples, as follows:

First Series—Ohio seed sown in green-house benches in February, maturing in June.

Second Series—All varieties sown in field in May, maturing in August.

Third Series—All varieties sown in field in July, maturing in September.

FIRST SERIES.

The seed from the Ohio station was received in the winter. A small portion of the seed from each of the five varieties was at once sown in our green-house, February 5, to determine the development of smut under these peculiar conditions. The plants grew very luxuriantly, but did not reach the flowering and fruiting stage in as short time from sowing as did those grown out of doors. In June, when fully headed out, the per cent. of smut* on these was found to be as follows:

Variety.	Per cent. of Smutty Stalks.
Race Horse,	15.6
Black Norway,	15.6
Mammoth Russian,	8.7
American Banner,	8.7
Black Prolific,	11.5

SECOND SERIES.

On May 4th one plat of each of the varieties received from the various stations, together with several plats of Vermont grown seed, were sown on well drained clay soil. The seeding was done with a horse drill, which placed the seed at a pretty uniform depth of one and one-half inches. In July, as the plants became fully headed out, the per cents of smut were determined by counting sound and smutty stalks in one drill of each plat. The results obtained from these countings are included in the following table, together with these reported from the home stations, where samples of seed oats were sown, duplicating those sent to our station for this trial.

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*A very peculiar development of smut occurred on the Black Prolific variety under the conditions of this green-house culture. The fruiting of the fungus, visible as the familiar black smutty masses, is usually confined to the flowering parts of the oat plant, viz., to the ovaries and surrounding scales or glumes. In a considerable proportion of the smutty plants of this variety, however, the sporulation occurred on the upper leaves as well as on the fruiting portions. The smutted portions were usually at the apexes of the leaves, and the epidermis over these portions was in many cases ruptured before the smutted panicle was protruded from its sheath. Upon microscopical examination these spores showed no differences from spores produced in the usual location.

Source of Seed.	Variety,	Per cent. Smut at Burlington.	Per cent. Smut at Home Station.
Illinois,	Pringle's Progress,	6.6	14
Indiana,	White Schenan,	3.8	1.
"	Black Prolific,	8.1	1.6
Iowa,	....	3.7	......
Michigan,	American Banner,	4.1	....
N. Dakota,	Sample " No. 2,	9.6	18.2
"	" " " 3,	26.8	26.6
"	" " " 4,	19.8	18.8
Ohio,	Race Horse,	49.6	42.2
"	Black Norway,	31.2	45.2
"	Mammoth Russian,	25.2	19.5
"	American Banner,	37.7	34.6
"	Black Prolific,	29.4	31.
S. Dakota,	Dakota Grey,	37.8	23.7
"	White Wonder,	32.6	37.7
"	Jeanette Canadian,	3.6	4.
"	White Canadian,	13.6	7.3
Wisconsin,	... .	6.8	2.3
Wyoming,	Bonanza,	58.8	26.
Vermont,	White Schonan,	5.7	.9* 3.6†
"	"Common White,"	4.4	.2† 5.3†
	Averages,	21.6	16.7

* Vermont seeds sent to Indiana Station and grown there.

† Vermont seeds sent to South Dakota Station and grown there.

THIRD SERIES.

July 15 a third series of plats were sown immediately adjacent to these last, and seed from the same sacks used. The oats came up well, but were soon attacked by rust and insects and made a poor growth in consequence. A fair per cent. of them headed out in September however, and were nearly mature when killed by frost. Frequent examination of these plats failed to reveal a single smutted plant.

SUMMARY OF RESULTS.

The results so far as concerns the development of smut may be briefly summarized as follows:

The Ohio seed grown in the green-house developed only about one-third as much smut as when sown out of door at the usual season.

When sown in July and maturing in September no smut whatever was developed, although the seed was from the same source as that which produced in some cases over 50 per cent. of smut when sown earlier in the season.

Comparing the amount of smut produced from Western seed sown in Vermont with that occurring where duplicate lots of seed were sown at the various Experiment Stations from which the seed was sent, the average is in most cases higher in Vermont than at the other stations. Three-quarters of the twenty samples showed a larger per cent. of smut when grown in Vermont than at the home station.

It is evident, therefore, that there were some conditions surrounding the regular oat crop grown at Burlington during 1895, which were peculiarly favorable to the development of smut. This is the more striking since our observations of previous years* had tended to show that, on the contrary, the conditions existing in Vermont usually tend to diminish the amount of smut.

It is manifestly of considerable practical importance to learn, if possible, what these varying conditions are. It is known that the fungus which causes the disease can gain an entrance only into the seedling oat plants, and that this infection usually occurs from spores which are inclosed alongside the oat kernel within the husks or glumes. The conditions which favor the germination of the oat kernel favor likewise the growth of the fungus spores, and this fungus being thus favorably situated at once penetrates the tender young tissues of the seedling oat plant Once inside, the fungus pushes its way to the point of active growth in the apical bud and in its growth keeps pace with the growth of the plant until the time of the oats flowering, when the fungus appropriates the nutriment elaborated by the oat plant and produces therefrom a mass of its own dusty spores. From the time of germination there exists, we may suppose, a contest within the tissues of the oat plant, the oat striving to outstrip its unwelcome associate in its growth that it may mature its normal fruit. There is evidence of this in the hastened maturity of oat plants infected with the smut, such plants "heading out" earlier than their more fortunate fellows. That the oat tissues do in some cases at least partially outstrip the fungus in this race is shown by the fact that it is not uncommon to find the lower portion of the cluster or panicle of oats smutted while the upper portion has escaped the disease, having, as Dr. Brefeld has explained, grown away from the fungus.

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*See Vt. Exp. Sta. Rep. 1893, p. 65.

With these facts regarding the life history of the fungus in mind it is evident that surrounding climatic or soil conditions may at any point in the contest so favor one or the other of the contestants—either the oat or the smut fungus—as to decide which shall come out victorious. Thus it is possible that the conditions of the soil at the time of the germination may favor one more than the other, or that conditions existing later during the period of combined growth of the oat plant and fungus may tend to give one or the other the advantage.

It has been shown by European investigators that the conditions of temperature during the period of germination directly determine the ability of the smut fungus to enter the seedling plants. It was, therefore, assumed at the beginning of our work that differences in soil temperature during the period of germination might, in some measure at least, account for differences in per cents of smut in the resulting crop.

The various other Experiment Station workers were, therefore, asked to contribute data concerning the conditions surrounding the germinating grain. Many kindly complied with this request. The statements are upon so different bases, however, that exact comparisons are impossible. We, therefore, give only those surrounding the germinating oats at our station, viz., soil temperatures and rainfall, and leave the results unexplained.

SOIL TEMPERATURES, FIRST SERIES, OATS RAISED IN GREEN-HOUSE.

Sown February 5. Temperature taken by setting bulb of thermometers in the soil to the same depth as seed lay. The average temperatures as registered by three thermometers in different parts of the beds follow.

Dates.	*Temperatures in degrees Fahrenheit.*						
	6 A. M.	8 A. M.	10 A. M.	12 A. M.	3 P. M.	7 P. M.	10 P. M.
Feb. 6.	..	..	49	53	53	48	45
" 7.	41.4	44	59	61	60	50	45
" 8.	47	48	49	56	53	49	47
" 9.	47	48	49	56	55	50	49
" 10.	47	48	59	68	68	60	55
" 11.	48	50	59	66	71	59	57
" 12.	53	56	65	66	65	58	57
" 13.	52	54	60	64	53	54	53
" 14.	52	..	68	68	74	58	54
" 15.	50	..	66	68	..	64	52
Extremes	53 43	50 44	68 47	68 53	71 53	64 48	57 45
	—	—	—	—	—	—	—
Averages,	48	50	58	62	62	55	51

Oats began to appear above ground February 12, and were 1 to 3 inches high by February 15.

SOIL TEMPERATURES, SECOND SERIES.

The second series planted in the field May 4 had soil temperatures taken only three times daily, each reading given below being the average of the temperatures taken at five different points in the field by means of a thermometer with bulb sunk in the soil to the depth where seeds lay and allowed to remain there five minutes before reading was taken.

May 6, 5½ P. M. average 24.5°.

Dates.	*Temperatures in degrees Fahrenheit.*		
	6½ A. M.	1½ P. M.	7 P. M.
May 7,	63	81	75
" 8,	64	84	70*
" 9,	64	84	81
" 10,	71	88	76
" 11,	65	87	75
" 12,†	55	54	49
Extremes,	65 55	88 54	76 49
Averages,	62	80	69

May 6, first roots were just starting from seed.

May 9, first leaves appearing above ground.

May 10, nearly all plants above ground.

SOIL TEMPERATURES, THIRD SERIES.

Sown in field July 15th. First leaves appeared above ground about July 20.

Dates.	*Temperatures in degrees Fahrenheit.*		
	6½ A. M.	1½ P. M.	7 P. M.
July 16,	63	68	65
" 17,	65	84	75
" 18,	64.5	85	72
" 19,	64.5	86	73
" 20,	70	92	77
" 21,	70	93	78
Extremes,	70 63	68 93	78 65
Average,	66	84	73

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* Heavy rain.

† Cold rains all day.

2. THE GENERAL OCCURRENCE OF OAT SMUT IN VERMONT IN 1895.

In continuation of similar observations of previous years, the amount of oat smut was observed in a number of fields about Burlington aside from the experimental plats previously described. The result of the examination of nine such fields in South Burlington, all of which had been sown with seeds oats obtained from some seedsman and a numb er of which were known to be "Western" seed was as follows;

Total number of panicles, 3140; number of smutty, 102.

The per cent. of smut (3.25) is higher than in most previous years. Nine fields in this vicinity examined in 1894 showed 1.7 per cent. of smut, while the highest per cent. found in any field was 7.5, some smut being found in all of the fields.

In addition to these observations a circular letter was sent to a number of farmers about the State asking that samples be taken from their oat fields* and sent us for examination as to amount of smut.

In reply samples were received from thirty-eight different localities. A careful examination of these for smutty panicles showed that:

Fourteen were entirely free from smut; six had less than 1 per cent.; nine had from 1 and 2 per cent.; five had from 2 and 3 per cent.; one had from 3 and 4 per cent.; two had from 4 and 5 per cent.; one had from 5 and 6 per cent. of smut.

The average amount of smut in the 38 was 1.49 per cent.

The average of the entire 47 examined in 1895 was 1.9 per cent.

In comparison with this the average amount found in 81 samples examined in 1892 was 1.6 per cent. of smut and of 97 examined in 1893 this average was .76 per cent. of smut. By inquiry it was found that ten of the thirty-eight men who sent samples in 1895 had been using the same strain of seed continuously since 1892, and an opportunity is thus afforded for a more exact comparison of the relative smuttiness of the crops from the same strains of seed for the three years in which we have full data in our reports, viz.: 1892, 1893 and 1895. Averaging the results from these ten fields for each of the three years the results are as follows:

Average amount of smut from ten fields 1892, .36 per cent.

Average amount of smut from same strains 1893, .4 per cent.

Average amount of smut from same strains 1895, .57 per cent.

Conclusions. The results all indicate some variation in the amount of smut in the same strain of seed from year to year and further that there was more smut than usual in the oat crop throughout the State in 1895.

As heretofore only a very small per cent. of smut was found in the fields of painstaking farmers using home grown seed. A considerably larger per cent. nearly always occurred where "Western" oats were used for seed.

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* Similar requests had been sent to many of these men in 1892 and 1893. The directions for taking the samples were similar to those of 1893. See Rep. Vt. Exp. Sta. 1893, p. 62.

VI. THE ONION MILDEW IN VERMONT.

In 1889 serious trouble from an onion disease apparently of a fungus nature and variously designated as "blight," "rust" and "smut" was reported by onion growers from various sections of the State.* No specimens were obtainable then and although vague rumors have reached us from time to time no specimens or information from which the nature of the disease could be determined have been received previous to this year.

In September, 1895, a letter from E. E. Herrick, Jr., of Milton, stated that his onions were dying rapidly from a blight and asked advice as to the cause and remedy. A visit was made to Mr. Herrick's field where it was found that the most of the leaves of the onions were either dead or dying. The diseased leaves were more or less completely covered with a dirty greenish gray powdery mildew which was so uniformly associated with the disease even in the earliest stages as to at once indicate that it was the cause. A miscroscopic examination of this fungus confirmed the belief that it was the "onion mildew," long known and dreaded by European onion growers. This mildew was reported also a few years ago as very destructive to the onion crop in the Bermuda islands. It has been previously reported as occurring upon the North American continent in only a few scattered localities. [Madison, Wis , (1883); Ithaca, N. Y., (1889); Weathersfield, Conn., (1889); Ottawa, Canada, (1889.)] The cause is the fungus *Peronospora Schleideni, Ung.* which is closely related to the fungus which causes the late blight and rot of the potato.

As it was too late to attempt preventive measures in this field the appearance of the diseased plants was noted and the history of the occurrence of the disease learned. This was Mr. Herrick's first experience with onions on a large scale, but a neighbor who had grown the crop for years stated that the disease was usually more or less troublesome to him especially on soil where onions had been grown for several years in succession, and that in his own field, where onions had been raised the previous year also, the mildew had destroyed all his plants several weeks before it did those upon Mr. Herrick's land. As no onions had been grown before on Mr. Herrick's land to his knowledge it seems probable that the disease was conveyed to this field by spores, carried by the wind or insects from the blighting plants on his neighbor's farm. These spores are exceedingly delicate and short lived, but in compensation for this are produced in enormous numbers.

In considering how to combat this fungus successfully it becomes evident then that two courses are open to us. The first consists in learning more definitely how and where the fungus lives through the winter, and having learned this to attempt to destroy it before it attacks the succeeding crop. The second is by means of fungicides applied as sprays or otherwise to protect the healthy leaves from infection by spores from diseased plants.

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* Fourth Rep. Vt. Exp. Station, 1890, p. 141.

Experiments will be undertaken along this second course the coming summer, trial being made of bordeaux mixture and other fungicides and it is suggested that any fearing the disease make trial of the same.

It seems quite probable that as much or more good may be accomplished by preventive measures as mentioned in the first course above, viz.: after having learned how and where the fungus lives through the winter to try to prevent its reaching the succeeding crop. Fortunately others have already given a considerable information regarding this matter.

The fungus may pass the winter in two ways and probably only two. The first way is by penetrating and living in onion bulbs upon which, if they are set in the garden in the following spring, an abundant crop of spores will be produced and from these the disease may be started afresh.

The second way in which the fungus may live through the winter is by means of resting or winter spores (*Oospores*) which are longer lived and more resistant to cold and similar adverse conditions than are the common summer spores.

Such spores are of common occurrence in related species of fungi and have been found in the case of this onion fungus in Europe and Bermuda. Their occurrence in this country has not been previously observed, and Professor Dudley, after studying the disease at Ithaca was of the opinion that the disease as it occurred there was propagated by the fungus hibernating in the bulbs.

Mr. Herrick believes that the fungus in these fields is probably not propagated thus by means of diseased bulbs, as few or no bulbs are planted and the disease is most troublesome on onions grown from seed. Moreover, miscroscopic examination of the diseased onion leaves taken from these plants at Milton revealed an abundance of the resting spores in all stages of development. These facts indicate that the fungus here at least is perpetuated from season to season by means of these resting spores. The observation already noted that the disease begins its attacks and is most severe on soil that has grown onions the previous season, also favors this idea.

In order to test the correctness of this conclusion a barrel of soil has been scraped from the surface of a field at Milton where onions have been grown for two succeeding years and brought to Burlington. Here it has been strewn over the surface of a portion of a green house bench and onions are being grown (December, 1895,) from seed upon it, while others are growing upon uninfected soil in an adjoining bench. The results will be awaited with interest.*

If the above conclusion proves correct that the disease is propagated over winter by such resting spores which are produced in the leaves of diseased onion plants, then much can be done in the way of prevention by carefully gathering all such diseased leaves in the autumn and burning them. If this were carefully and thoroughly done it is probable that the infection of the soil could be prevented so that a crop of onions could be safely grown on the same piece a second season. Unless such precautions are taken, however, some other crop should be grown on the infected soil for at least one year that the fungus may be starved out.

VII. THE HAWKWEED.

Mention was made in our last Report (page 114) of several weeds which are already troublesome pests or are threatening serious invasion of our State.

Unquestionably the worst of these recent invaders is the golden hawkweed or ladies' paint brush, ***Hieracium aurentiacum.*** This is already thoroughly established in roadsides and fields of northwestern Vermont and is each year spreading into new sections. In many localities its rapid spread and the difficulty of its extermination has caused serious alarm.

Considerable correspondence upon its prevalence and means of eradication led us to undertake experiments to test the best means of quickly killing it in grass land. These experiments will be continued another season before detailed publication is made, but they clearly justify the following conclusions:

First. The hawkweed can be completely exterminated in less than one year by plowing, followed by clean culture so persisted in as to allow of no continued growth of the plant above ground.

Second. Salt applied to the plants kills them very quickly and the amount necessary to do this is not sufficient to materially injure the grass.

We recommend, therefore, the use of salt, applied liberally broadcast, in all cases where a limited amount of the weed is to be exterminated.

Where a large area of tillable grass land is infested and is to be cleared, it seems probable that an application of the cheapest grade of salt obtainable, about one or two tons per acre, will prove profitable before the land is plowed, this to be followed by clean cultivation of a hoed crop.

It is hoped that a bulletin treating of this weed will be ready for publication during 1896 or early in 1897.

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* The delayed publication of this report enables us to add that the mildew appeared in April upon the plants growing in the soil taken from the onion field while the other plants growing upon clean soil are entirely free from the mildew.

REPORT OF THE ENTOMOLOGIST.

By G. H. Perkins.

The past year has been unusually prolific in insect pests. Probably the character of the season last year and the dryness of the early part of the present year have much to do with this. As a rule a dry season is more favorable to the increase and development of injurious insects than a wet one. Climatic conditions, the amount of rain, degree of heat and cold, and the like, affect very profoundly the increase of many insects. This alone is not the cause of periodic outbreaks of insect hordes or of their sudden disappearance, or of the great abundance of this or that species during one season or more, and then its disappearance or at least scarcity during other seasons. There are many other conditions than those afforded by the weather to be considered in investigating the lives and characters of our insect foes, but, perhaps, no conditions are more potent in the case of many species than those found during periods of unusual heat or cold, drought or flood.

Not only are many kinds of injurious insects greatly affected by climatic conditions as to their increase and growth in a given locality, but their range and spreading from one region to another is also determined largely by the same thing. Certainly there are many other conditions which must not be overlooked, any of which may in given cases determine the increase and spread, or the decrease and restriction of injurious insects. Very important among these is the presence of parasitic insects which often so prey upon injurious species that these latter are held in check by this means alone. It is often one of Nature's compensations that, while injurious species, by reason of the more abundant supply of food afforded them by cultivation of crops, are able to increase enormously and to become a serious menace to the prosperity of the man who cultivates the crops, this very increase of the harmful species soon causes a corresponding increase in species that either prey upon them directly or are parasitic and thus indirectly but surely destroy them. It is everywhere the food supply which more largely than anything else decides the increase or the destruction of forms of life. Insects that for ages, no one can tell how many, have fed upon a limited supply of wild plants and, because the supply of food was limited, have been themselves limited in increase, suddenly discover that man has interfered with the equilibrium of Nature and by his cultivation of certain plants has vastly enlarged the food supply. This discovery once made, the insects are not slow to take advantage of the new state of things and, leaving their long-restricted supplies, they swarm forth to devour the richer and more luxuriant crop regardless of the fact that it has been grown not for them, but for man. Now for a time, but seldom for a long time, there is trouble. Unnatural conditions, brought about by man for his own advantage, and sure in the end to be for profit, are for the time being to his disadvantage. In the warfare that ensues, the bugs too often, simply by prodigious increase of numbers, overwhelm and utterly discomfit their human enemy. But man is not alone in this strife. He may do much and may even be finally victorious through methods of his own devising and executing, but he has in addition powerful allies who speedily come to his aid. Nature's laws decree that no form of life shall multiply without restriction or check and just as the increase of food supply is sure to add to the number of those living creatures that thrive upon it, just so does the increase of these creatures augment the list of other living beings which thrive upon them, that is of predaceous and parasitic forms, by which the pest is finally checked. Sooner or later the adjustment is sure to come, but meanwhile man is naturally impatient at the loss of his crops. He cannot wait for the slow processes which are going on in the natural world to restore equilibrium and he must try his hand at helping And this is the chief function of the economic entomologist. It is for him by investigation and experiment to aid the farmer in keeping in check those insects which have increased because he has planted and cultivated crops upon which they feed. In most cases the task of destroying noxious insects becomes simpler every year because parasites appear in ever increasing numbers and render more efficient aid. Law, not chance, controls all life. It may be, and often is, very difficult to discover the law or laws which determine the presence or absence, the abundance or scarcity of any animals or plants, or, in the matter under consideration, of any species of insect. Some species are more easily affected by one condition or set of conditions, other species by others. Of course food supply must determine in some measure the presence in greater or less numbers of any insect, but climate is also a powerful factor. Some insects are more completely controlled by the former, some by the latter. Thus for example insects like the Colorado potato beetle if supplied with abundant food are comparatively indifferent to diversities of climate or season. Other species, as the chinch bug, are severely limited by climate and the character of the season, and others, as the canker worm, are more likely to be kept in check by parasites. Besides the conditions named as affecting insect growth, there are very likely others, thus far unknown or at any rate not well understood, for it is often true that our wisest entomologists are quite unable to discover why an insect is abundant this year, though scarcely seen last, or, why, being abundant last year, it has well nigh disappeared this year.

It is very obvious that it is of the greatest advantage to the entomologists to know all the whys and wherefores in insect life. Indeed only so far as he does understand them can he intelligently and successfully combat his insect foes.

During the past year the farmers of Vermont have suffered from the attacks of several species of insects which have not been greatly destructive in the State for a long time. Chief of these are the chinch bug and the army worm, both of which will be considered more fully subsequently. Of old offenders, the apple maggot or railroad worm, tent caterpillars, wire worms, cut worms, the bud moth, appletree borer, grasshoppers, the black potato bug, and bark lice, have been most troublesome. Some of these pests have been confined to a few localities, while others are widespread over the State. Concerning some of the above named species about all that can at present be said, has been given in former Reports, others will be discussed in the following pages.

APPLE MAGGOT.

The APPLE MAGGOT or railroad worm, *Trypeta pomonella*, Walsh, is one of the most troublesome of insects in a state like Vermont, in which the apple is so important a crop. This insect was fully considered in the Seventh Report of this Station and I can add little to what is given there. No very satisfactory remedy has thus far been discovered, though, as a preventive measure, it seems to be true that allowing stock, and especially swine, free access to the ground under the infested apple trees proves very effectual. The *recently* fallen apples are, if the tree is infested, almost sure to contain larvæ of the apple worm, and, if they are devoured, of course a period is put to its further depredations. I have emphasized *recently* because after the apples have lain for a time upon the ground, the worms may leave them and burrow below the surface where they change to pupæ. Hence, while stock would materially aid in checking the increase of the worms by devouring the fallen fruit, swine would do much more efficient work, since they not only eat the apples which may have fallen, but root up the ground and thus destroy those larvæ which have left the fruit. I do not think that any sort of spraying would avail against this insect. It is a difficult insect to handle and has thus far baffled the ingenuity of entomologists.

TENT CATERPILLARS.

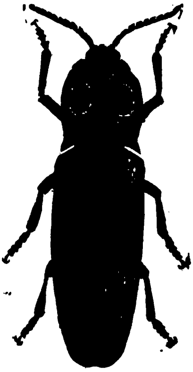
In Bulletin No. 11 of this Station, TENT CATERPILLARS are considered, and those especially interested in this insect are referred to that account for a description and life history of the species most common. It appears to have been unusually abundant during the early part of the present season, and therefore to have caused considerable alarm. There are many insects which may increase and ravage greatly, at least for a time, in spite of all that can be done to prevent, and, without exposing the farmer to just censure for neglect. The tent caterpillar, however, is not one of these. Directly or indirectly the farmers of a region infested by this insect are to blame, for it is one of those enemies which can be controlled and routed. If tent caterpillars are destructively abundant it is because they have been allowed to become so through neglect and carelessness. The worm is itself large enough and conspicuous enough to be readily observed, and, as if to aid the farmer or fruit grower, it makes those nests which, in certain seasons, form so unsightly a feature of our roadside landscape. When especially abundant it may not be an easy matter to destroy or even wholly to check the worms, but if, year by year, the nests are persistently and thoroughly destroyed, not only on orchard trees, but as well on the wild cherry or apple trees that grow along roads or in the edges of a forest, there will be no pest of tent caterpillars. This insect affords a most excellent object lesson upon the advantage and necessity of fighting insects whenever they appear, not waiting until they become so numerous as to cause alarm. The natural food of the tent caterpillar is the leaves of the common wild cherry and from this it spreads to cultivated apple and other trees. If road masters or others in authority could be induced to exercise their power to keep the roadsides and similar places free from this insect, much would be gained. There should be a state law requiring this, but, some years ago, when it was proposed by a member of the legislature to enact such a law, he was laughed to scorn by the representatives assembled. Such a law should also include private grounds, after the owner duly warned of neglect still refused to do his duty. The most obvious method of destroying this insect is to attack it when assembled in the nests or tents. It is at home during the night, but wanders about the tree during the day in search of food, so that the nests should be taken in hand either at dark or early in the morning. They may be cut off and burned, or burned on the tree, or sprayed with Paris green, since this latter, especially if the adjacent leaves are poisoned, is efficacious. A web out of reach of ordinary remedies may be destroyed by firing a charge of powder from a musket into it.

The common striped potato beetle needs no notice in a paper like this. It is an example of a very injurious insect which farmers have learned how to control very completely. There is, however, another potato beetle, which has long been found in Vermont and which does not appear to be ordinarily very injurious. During the present year, however, it has attracted attention in several towns by its depredations. It is one of the group known as blister beetles and is called by entomologists, *Epicauta pennsylvanica, De G.* This species is a long, narrow beetle of a uniform dull black about half an inch or more in length. It feeds often on golden rod and from this it spreads to adjoining potatoes, hence it is never wise to allow clumps or borders of golden rod to grow about potato fields. Indeed, as has been noticed in previous reports, it is always best, to keep the borders of fields clear of weeds or any other rubbish, not only because it is more thorough farming, but also because weeds often serve as breeding places for insects.

WIREWORMS.

From several of the towns in the state complaints have come that WIREWORMS were greatly injuring the crops, usually corn or potatoes. These and the various species of Cutworms, living as they do under ground, out of sight and out of reach, are peculiarly difficult insects to manage, since they are protected by their habits from many insecticides which could be used under different circumstances. More satisfactory treatment of wireworms than has yet been discovered is greatly to be desired, but at least it is possible to say that some remedies which have been regarded as of value are not helpful, thus saving unnecessary trouble. Some knowledge of the insects themselves must be of value, for the more we can know of any insect the better. For much of what follows I am indebted to Bulletin 107 of the Cornell Station, by M. V. Slingerland, to whom I am also much indebted for electrotypes of the cuts of wireworms which follow. Prof. S. A. Forbes has also written very fully and helpfully of wireworms in the 18th report of State Entomologist of Illinois and from Prof. Forbes' plates given in this report most of the illustrations were originally taken. An abstract of this report is published in Bulletin 44 of the Illinois Station. It is somewhat discouraging to learn that, at a station which is probably excelled in equipment by none in the country, after three years of study and experiment by such able entomologists as Prof. Comstock and Mr. Slingerland, the final conclusion should be that no satisfactory method of treating wireworms had been discovered. Nevertheless very valuable information was gained and the labor and expense involved was by no means lost. As every observing farmer who has had reason to examine wireworms knows, they are not all alike in appearance, though there is a general resemblance. There are many species, some of which are not injurious to crops. The worms, so called, are larvæ of beetles, known as snapping, or click beetles, because they spring into the air when placed on their backs with a sudden snap. They do this in order to get right side up, since they cannot easily right themselves by using their short legs when they fall on their backs, but must snap themselves about until they come down on their feet. The largest native species is that shown in Figure 1, which is rather larger than nature, though rarely specimens are found nearly as large as the figure, but usually the species is not more than two-thirds as large. I give this figure not because the beetle is injurious, for it feeds in the larva state upon deadwood, but because it shows more clearly than the other figures the peculiar arrangement of the thorax and abdomen by means of which the jumping is accomplished. Dr. Harris well describes this as follows: "On the under side of the breast (thorax) between the bases of the first pair of legs there is a short, blunt spine, the point of which is usually concealed in a corresponding cavity behind it. When the insect, by any accident falls upon its back, its legs are so short and its back so convex, that it is unable to turn itself over. It then folds its legs close to its body, bends back the head and thorax and thus

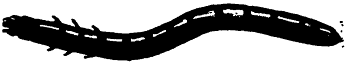
Figure 1.



Alaus Oculatus L.
A Large Snapping Beetle.

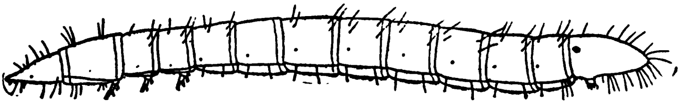
unsheaths its breast spine; then by suddenly straightening its body, the point of its spine is made to strike with force upon the edge of the sheath, which gives it the power of a spring and reacts on the body of the insect, so as to throw it perpendicularly into the air. When it again falls, if it does not come down on its feet it repeats its exertions until its object is effected." (*Insects Injurious to Vegetation*, p. 51.) I have noticed many species of snapping beetles in Vermont, I presume not less than fifty, but of these only a few need the special attention of the farmer since the troublesome wireworms are larvæ of perhaps a half dozen species, the rest being either not fond of cultivated crops and vegetables or too few to be of noticeable importance. In warmer climates they are more abundant. Prof. Forbes says that in Illinois there are not less than a hundred species, that eight different species attack corn, and others wheat, grass or other crops. The general appearance of all the Wireworms is much the same and there seems little need of confounding them with worms of a different sort. The worm is well shown in figure 2, natural size, while figures 3 and 4 show wireworms much enlarged. The body is covered with a more or less hard, smooth brown crust. The joints are very distinct in all. The head is usually less cylindrical than the rest of the body and is furnished with often quite conspicuous jaws. Each of the three joints behind the head bears a pair of legs.

Figure 2.



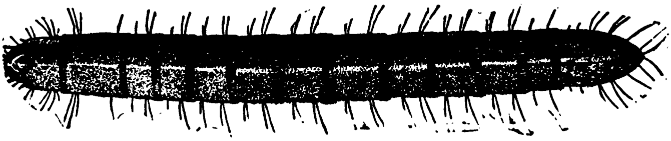
Wireworm. Natural size.

Figure 3.



Corn Wireworm, showing the back. Enlarged 4½ diameters. After Forbes. Natural length about ¾ inch.

Figure 4.

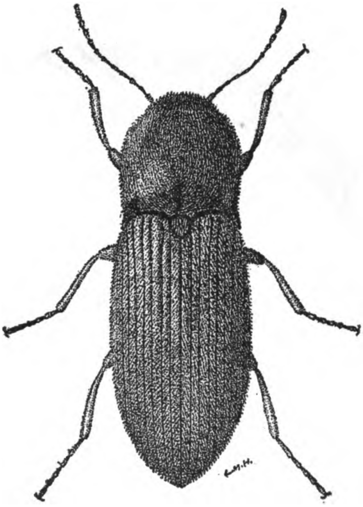


Common Wheat Wireworm, showing the side. Enlarged 5 diameters. After Forbes. Natural length about ¾ inch.

The body is slender and the length is from half an inch in some species to nearly three times as much in others. They are usually active in their movements and wriggle vigorously when taken in the hand. The original home of the wireworms seems to be sod, from which they go forth to the better feeding which cultivated fields afford whenever occasion may offer. Hence land recently in sod when plowed and planted with corn or grain is much more subject to their attacks than other fields. Some species seem to prefer corn, others wheat, others potatoes, but probably all of them will attack any of these and other crops. They seem to be more common on heavy than light soil. In the case of corn which in this state is the crop which suffers most, they begin by attacking the kernel as soon as it is planted. What they do not destroy in this way they damage later by eating the roots as shown in figure 9, and finally they may bore into and through the stalk. In case of grain or grass they attack roots and stem. Here in Vermont they often do considerable damage to potatoes. Some crops, as notably clover, they do not attack and this fact can be utilized in arranging a system of rotation by which the ravages of these insects may be at least lessened. The complete life history of any of the different species of wireworm is not known. Forbes in Illinois and Comstock and Slingerland in New York have followed much of the development of some species and from their observations it seems tolerably certain that the larva or worm stage lasts three, or in some species four years, or possibly but two years in a few species, during the whole of which time they live in the ground and devour such crops as may be accessible to them. It is easily seen that a given number of wireworms distributed somewhat evenly over a ten acre meadow might find sufficient food in the grass roots and yet do no very noticeable damage, but when the same field is plowed and planted with corn, the worms are compelled to congregate in the hills of corn so that their ravages are concentrated and thus greatly increased. Their most serious injury is inflicted during the second year after sod land has been broken up, since by that time the grass roots have so far died as to be of no value to them as food and their whole support must come from the planted crop. Whether fully grown or not, they stop feeding late in the fall and remain dormant during the winter. When they are mature as larva, they burrow a few inches below the surface of the ground and make a little oval, or roundish cell, in which they remain about three weeks and at the end of this time they come out as beetles, This is during the latter part of the summer. Prof. Forbes says: "A large part of these fully developed beetles remain under ground until spring, enjoying there the protection of the oval earthen cavity or cell formed by the larva as a preparation for prepation. A part, however, come forth from the ground in the fall, passing the winter in sheltered places."—18th Report, Illinois Entomologist, p. 30.

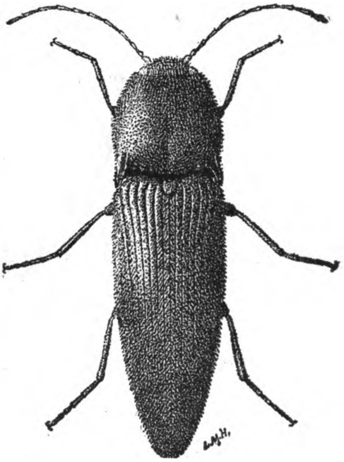
As we have seen, there is a marked family likeness found in all the species of beetles into which the wireworms develop and which in turn lay the eggs which hatch into the worms. The following figures, most of which are considerably enlarged, show the form and appearance of some of our more common species. Figure 5 shows the beetle of a species more commonly attacking wheat, though not by any means confined to that plant, as it often attacks corn and other grains. The wireworm of this beetle is shown in figure 4.

Figure 5.



Agriotes mancus, *Say*. Enlarged 7 diameters. Natural size about ⅓-in. long. After Forbes.

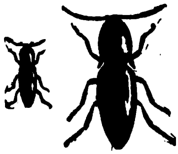
Figure 6.



Melanotus communis, *Gyll*. Enlarged 4 diameters. Natural size about ½-in. long. After Forbes.

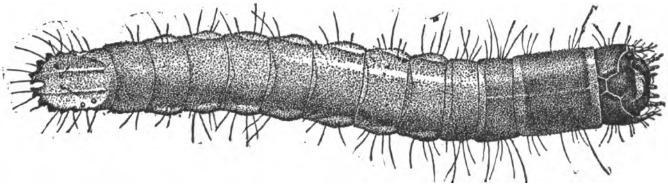
In figure 6 another wireworm beetle is shown, the larva of which is very much like that shown in figure 3, which illustrates an allied form found very commonly in the corn fields of Illinois. Still another species is shown in the adult in figure 7 and larva figure 8. The usual method of feeding is shown in figure 9, which is taken from one of the experiment boxes at the Cornell Insectary. The plant shown in this figure was growing in a box with glass sides, through which the worms can be seen feeding. Just above the earth on the stem is a beetle of the species shown in figure 7, while another species, that shown in figure 5, is seen on one of the leaves.

Figure 7.



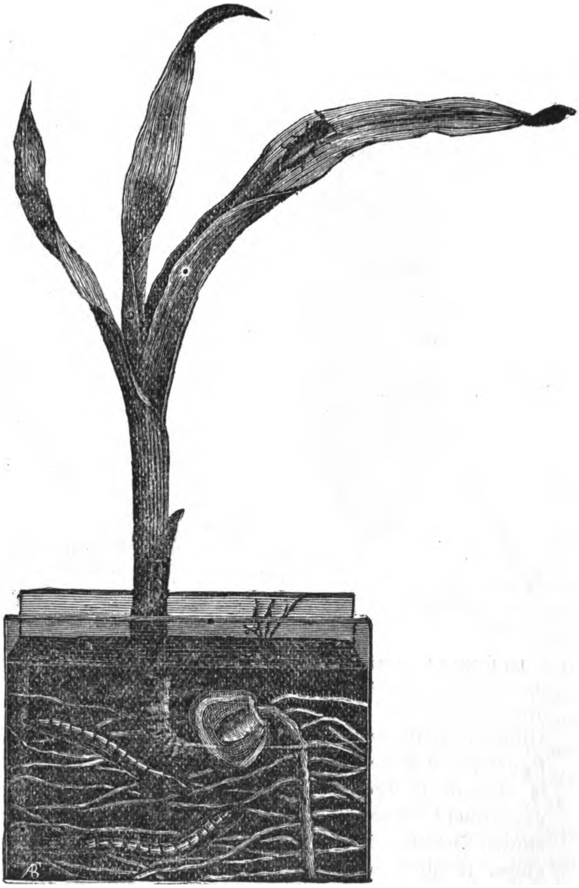
Drasterias elegans. *Fabs*. Left hand figure natural size, right hand enlarged.

Figure 8.



Wireworm of *Drasterias elegans*, *Fabs*. Enlarged 7 diameters. Natural length ½-in.

Figure 9.



Growing corn plant attacked at the roots by Wireworms. Beetles resting on the plant.

Remedies. Not only are wireworms difficult to destroy on account of their underground life, but also because of their exceptionally rugged constitution. Most insects succumb to the effect of violent poison, but these worms seem to be remarkably insensible to poisoned food and this adds much to the difficulty of dealing with them. Mr. Slingerland says: "We coated kernels of corn with varying amounts of Paris green and flour and carried on a large number of experiments covering a period of nearly two years. The only apparent result of the coating was to retard the sprouting of the seeds. We saw wireworms destroy several of the coated seeds without apparent injury to themselves." So, too, Prof. Forbes: "We fed thirty-seven wireworms on corn soaked for seven days in a mixture of water and Paris green. The corn was covered with a coating of the green poison and was eaten freely by some of the worms without killing them. Twelve others were fed on corn soaked in an alcoholic solution of arsenic, were not injured by the poison though feeding freely on the corn. Corn soaked in a solution of strychnine, 4 grains to ½ pint of water, over night, and fed to seven wireworms June 28 had not affected them by July 5, although the corn was slightly eaten." From these and other experiments it does not seem at all probable that any attempts to poison the worms would be successful. No more efficacious is the old remedy of coating the kernels of corn with tar, soaking them in brine, copperas water, kerosene, turpentine, etc., all of which have been thoroughly tried and found useless. Various sorts of traps to capture the worms or beetles have been devised, but most of them have been failures. Small bundles of poisoned clover, scattered about the field and left during the night, have proved useful in destroying the beetles. Starving the insects by letting ground lie fallow has been recommended, but it is not at all probable that this is worth while in the case of most insects and it is certainly of no use so far as Wireworms are concerned. Prof. Forbes is confident that "a judicious rotation of crops in which clover follows always upon grass and is itself followed by corn" will prove a valuable expedient for checking the ravages of these worms. "According to this plan pastures and meadows of grass might lie unchanged for several years, being plowed, when broken up, in late summer or early fall and sown to clover in the spring. The clover should then be allowed to stand a second year, and might then be followed with corn with the positive assurance that the wireworms originally in the sod would by that time have entirely disappeared." Perhaps as nearly satisfactory a remedy that has been discovered is the following quoted from Mr. Slingerland. "The results of our experiments convinces us that much can be done towards checking the increase of wireworms by fall plowing. Wireworms live for at least three years in the worm or larva state. In this state they cease feeding about November 1st and hibernate till spring. When the worms are fully grown they change to soft, white pupæ which resemble the beetle in form. This change takes place in the species that commonly infests field crops during the month of July. The pupa state lasts only about three weeks, the insect assuming the adult form in August. But, though the adult state is reached at this time, the insect remains in the cell in the ground in which it has undergone its transformations till the following April or May, nearly an entire year, We found that in every case where we disturbed the soil so as to break these earthen cells, the insects within perished. This experience clearly indicates that if infested fields are plowed after July

20th and thoroughly pulverized and kept stirred up many of the little earthen cells may be broken and the tender pupae or beetles within destroyed. After three or four weeks of this thorough cultivation, wheat or rye may be sown." Cornell Bulletin 107, p. 48.

GRASSHOPPERS.

In quite a number of towns in years past the crops have been injured by "grasshoppers." Entomologically these insects are not *grasshoppers*, but *locusts*, very closely allied to and resembling the famous Rocky Mountain locust, and less closely allied to the anciently known and dreaded locusts of the old world. The Rocky Mountain species does not occur in the east. Our Vermont species are most commonly the Red-legged Locust, and more often a very similar form which has always been confused with it until a few years ago, when Dr. Riley described it under a new name, and which may be called the Lesser Locust. The ordinary appearance of the Rocky Mountain locust is seen in figure 10. In our species, of which I regret to be unable to give an illustration, the general appearance is almost precisely the same, except that it is smaller and the wings are shorter.

All locusts are eminently terrestrial in their habits, spending their lives on or in the ground, except during flight. Some species, as the old world locust, famous for centuries, collect in vast companies and migrate considerable distances. Something of this disposition is seen in the Rocky Mountain species. Our two common New England species do not usually migrate on the wing, although they may gather in large numbers. The life history of all the more common species is much the same. The eggs are laid as shown in figure 10, in the ground. This figure as well as those that follow were obtained by the kindness of Dr. L. O. Howard of the U. S. Department of Agriculture. The eggs themselves are long, oval white bodies, figure 10 c, and very much enlarged, figure 11. As figure 10 well shows, the abdomen of the female is

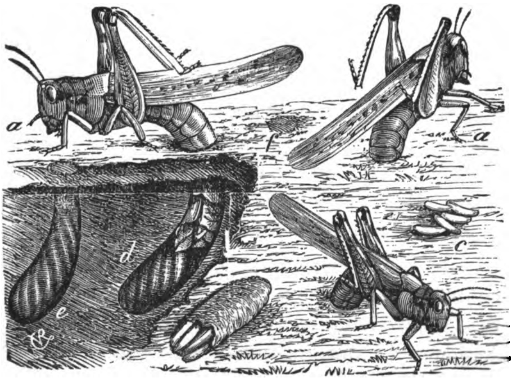


Fig. 10. Rocky Mountain Locust laying its eggs in the ground.

thrust into the ground in laying the eggs. At the end of the abdomen there are two hard, curved processes by the aid of which she is able to thrust the eggs below the surface. The hole made by the thrusts of the abdomen is usually curved. Says Dr. Riley: "When the hole is once drilled there exudes from the body a frothy, mucous matter which fills up the bottom of the hole. * * * * * After this an egg is deposited and then more frothy matter and another egg, and so on until the full complement of eggs is in place, the number ranging from 20 to 35, but averaging about 28. The mucous matter binds all the eggs in a mass (as shown in figure 12) and when the last is laid the mother devotes some time to filling up the somewhat narrower neck of the burrow with a compact cellulose mass of the same material, which though light and easily penetrated, is more or less impervious to water and forms a very excellent protection."

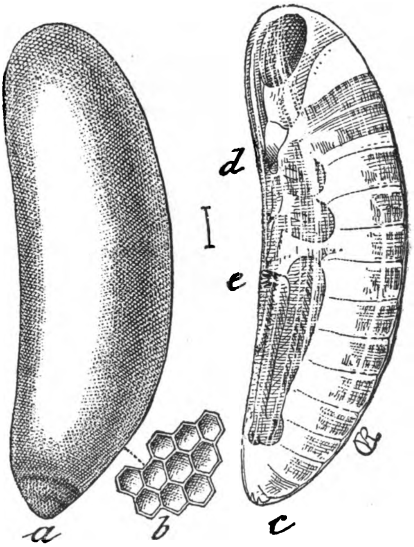


Fig. 11. Eggs of locust very greatly enlarged, (*c*) c shows through the shell the young locust just before hatching.

As may be seen in figure 12, which shows the mass of eggs seen from different sides, the eggs are arranged in a most orderly fashion in the burrow. Several of these egg masses are produced during the season. In our eastern species, the Red-legged and the Lesser Locust, the eggs remain in the ground unhatched till the following spring. There is a great difference in insects with respect to the likeness of the newly hatched larva to the parent. Some insects, like the wire-worms, for example, or moths and butterflies, do not resemble the parent in the slightest degree when they come from the egg, but pass through very complete transformation as they develop from the egg to the adult. Most insects are quite unlike the adult in the larva state, though in many the metamorphosis is less

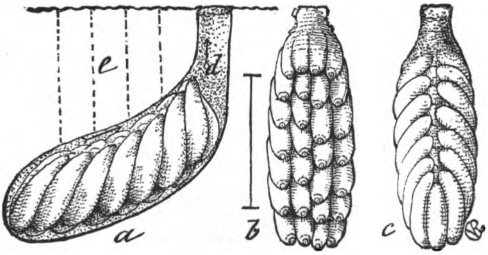


Fig. 12. Egg mass of Rocky Mountain Locust, enlarged. From First Report U. S. Ent. Com.

thorough than that just noted. On the other hand, young grasshoppers and locusts are quite like the adult, differing mainly in the proportions of the parts, the head being relatively larger and the wings being undeveloped Still, no one familiar with the adults would have any trouble in recognizing the young of any of the locusts or grasshoppers. Figure 13 will enable one to understand these differences in some degree, though it is not so distinct as could be wished.

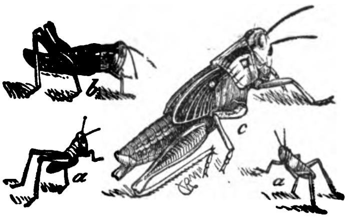


Fig. 13. Locusts of different ages; a a. just hatched; b fully grown larva; c pupa which is very nearly the form and size of the adult. From 3d Report U. S. Ent. Com.

The chief external character of the adult locust may be better seen in figure 14, which represents the largest of our species. It is not especially important from an agricultural standpoint, and is introduced here merely because it shows more clearly than do the other illustrations, the main external parts of the body of a locust. In common usage the terms locust and grasshopper are very much mixed, and a word respecting this may not be out of place. Most true locusts are now and then called grasshoppers, and some grasshoppers are called locusts, and I do not suppose that there is very much hope of doing away with this confusion of terms which is also found in other cases, as wasps and hornets, worms and caterpillars. The differences which entomologists recognize as existing between locusts and grasshoppers are not very obvious to a casual observer, and indeed the popular and scientific terms are badly mixed, for the true grasshoppers belong to the family *locustidae*, while the true locusts do not. The grasshoppers have very long, slender antennae, or feelers, usually longer than the body, and they spend most of their time on trees, bushes, etc., and the feet have four joints. The locusts have short antennae, never longer than the body, as in fig 14, spend most of their time on the ground, and have feet with three joints. The injurious "grasshoppers" are all

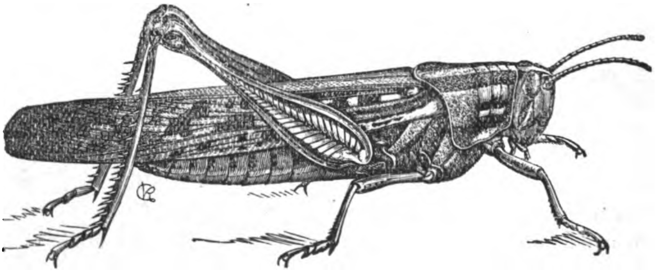


Fig. 14.

locusts. A not uncommon species which is not particularly injurious, but which is often mistaken for injurious species, is the Green-striped Locust, figure 15.

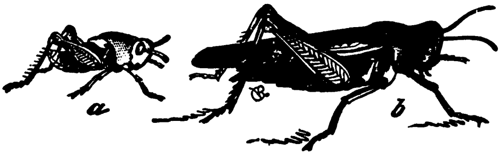


Fig. 15. Green-striped Locust; (a) young, (b) adult, natural size.

The three species with which the people of this country are especially concerned are, as has been noticed, very much alike in size and general appearance, and it is probably true that all are varieties of a single species, so that, as Dr. Riley suggests, the names will ultimately be written *Melanoplus femur-rubrum*, *De Gec*, for the Red-legged form, *Melanoplus*, *femur-rubrum*, *var*. *spretus* for the Rocky Mountain form, and *Melanoplus*, *femur-rubrum*, *var*. *Altanis* for the common eastern form which we call the Lesser Locust.

Yet to the economic entomologist there must always be a very considerable difference between the three, and especially between the two eastern and the western, for in habits these differ much more than in structure and form, and of course this is a very important fact so far as the effect upon crops is concerned. Perhaps the most obvious difference is found in the length and shape of the wings. The wings in the western Locust are much longer and are much more in use than in the eastern. In the former they are about a third longer than the abdomen, in the Red-legged form about one-sixth longer, and in the Lesser they are between the two, but our eastern species do not seem to be nearly so powerful in flight nor so ready to use their wings as the western, and hence they do not migrate as that does, nor does the migratory disposition seem to be as fully developed in them.

There are, fortunately, other differences of such nature that the far more mischievous Rocky Mountain locust does not come east of the Mississippi Valley, and when brought here cannot live, so that we need have no dread of such terrible visitations as those experienced in 1873 and other years in Kansas and adjoining states. Nevertheless the ravages of the eastern and smaller species have sometimes been sufficiently great to cause much alarm and real loss. It is safe to say that the eastern species will never cause such extensive and complete devastation of crops as did the western species during those memorable years of the "grasshopper plague," but for more than a hundred and fifty years it has been known and feared. As long ago as 1743 the locusts did great damage to crops in New England, and in 1749 they again appeared in vast numbers, so that the people were greatly alarmed, and days of fasting and prayer were appointed that the peril migh be averted by Divine interference.

In Dr. Dwight's travels, published in 1822, we find the following interesting record: "Bennington and its neighborhood have for some time past been infested by grasshoppers," (doubtless the Lesser locusts). "Their favorite food is clover and maize. But their voracity extends to almost every vegetable, even to the tobacco plant and burdock. Nor are they confined to vegetables alone. The garments of laborers, hung up in the field while they are at work, these insects devour in a few hours; and, with the same voracity, they devour loose particles which the saw leaves upon the surface of pine boards. The surface of a board fence, from which the particles had been eaten in this manner and which I saw, was novel and singular, and seemed the result, not of the operations of the plane, but of attrition. At times they collect in clouds and rise high in the atmosphere and take extensive flights, of which neither the cause nor direction has hitherto been discovered."

The apparently rather large story of their ravenousness, given above, is corroborated by other accounts. Dr. True, as quoted by Dr. Scudder in Vol. 1 of New Hampshire Geological Report, makes the following statement: "During the haying season the weather was dry and hot, and these hungry locusts stripped the leaves from the clover and herds grass, leaving nothing but the naked stems. So ravenous had they become that they would attack clover, eating it to shreds. Rake and pitchfork handles, made of white ash, worn to glossy smoothness by use, would be found nibbled over by them if left within reach."

This was in Maine fifty years ago, and from time to time since the locusts have committed serious ravages, though not usually extending over a large territory.

In the monthly report of U. S. Department of Agriculture for 1871 we find that in Caledonia County, Vt., "the locusts had been very destructive, and also that in Windsor County they were a terrible scourge, and they were abundant in Orleans County, and had done much injury to some of the crops in Windham County."

In 1872, the year following that just reported, the locusts were also very troublesome in Vermont, and more so in New Hampshire.

Although there does not seem to be any regular periodicity in the appearance of locusts in excessive numbers, it is evident that there are years of plenty and years of scarcity.

Our common eastern locust hatches in the spring from eggs laid during the preceding summer. It remains in the immature state about three months and, after reaching adult age and pairing, the females having laid their eggs, dies on the advent of cold weather.

Locusts have many natural enemies, and by these they are often kept in check and may be nearly destroyed. The list of insect enemies is quite long and among them some most strange ones. Dr. Riley found that the common white grub, as well as the larvæ of several other beetles, ate the eggs of both the western and eastern locusts. Wire worms also have been found feeding on locust eggs. There are several species of mites which are parasitic upon locusts, one especially, which is in many localities very destructive. Some years ago Dr. Riley called it "one of the most important of our locust enemies." I regret that illustrations of this species cannot be given, as was intended. The young mites are tiny orange objects which find their way as soon as they are hatched to the locusts, upon which they fasten themselves, feeding upon the fluids of their hosts. The mite grows rapidly and finally becomes an ovoid, eight-legged creature about one-twentieth of an inch long, of the same reddish or orange color as the young, but of different form and also different in habit. As we have seen, the young suck the juices of the locust, weakening and often destroying it. Their favorite location is at the base of the wings or on the larger veins, and they then appear most like some growth on the wings. The mature mites, however, do not live on the locust, but, the fully grown larva dropping from its host to the ground and transforming there, lives in the ground where it feeds upon animal and vegetable matter, including many locust eggs. Thus both in its young and mature state this mite renders great service. There are many beetles which devour locusts, such as the common bright blue or green tiger beetles and others.

Several specimens of the larva of one of our beetles have been sent during the year for determination. These are all of a species of one of the insect-eating beetles. This is figured in figure 16, the larva (*a*) and the beetle (*b*) natural size. This beetle destroys many cut-worms and such like pests, as well as locusts. A very curious enemy of the locust, as well as of some beetles and other insects, is the common hair-worm or hair-worms, for there are several species. The history of these worms is so peculiar and so little known to most people that I may be pardoned for introducing a brief statement of it here. The adult worms are usually found swimming about in pools, ponds, watering troughs and such places. It is then of the form of (*k*) in fig. 17, (see next page) of a dark brown color in some species, lighter in others. It is an enormous parasite relatively to the size of its hosts. I have taken from the abdomen of locusts and crickets hair-worms of such size that one is amazed that room could have been found inside the host for its assailant, and once two full-sized worms came from the abdomen of a

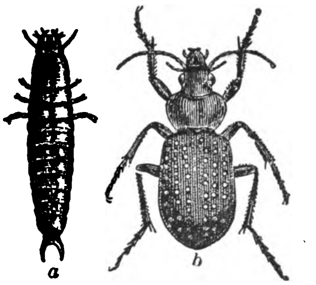


Fig. 16. Larva adult beetle, *Calosoma calidum*, one of the predaceous beetles, natural size.

crushed cricket. It is, I hope, unnecessary to remark that horse-hairs and hair-worms have no relation whatever to each other. The history is briefly as follows:

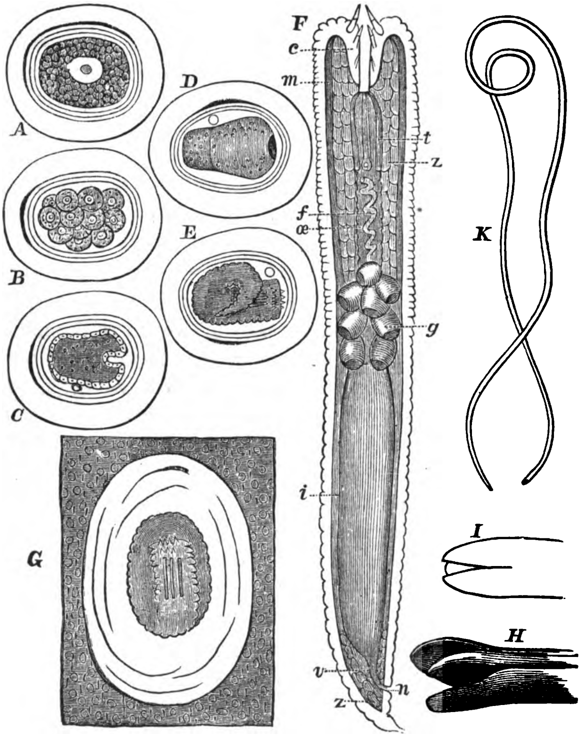


Fig. 17. ***Gordius aquaticus*****, hair worm. (a) Egg. (b, c, d, e) Egg in different stages of development. (f) Larva, showing internal structure. (g) Larva as encysted in a fish, all much enlarged. (k) Mature worm, natural size. From First Report U. S. Ent. Com.**

The eggs, figure 17 (a) are laid in the water, where they hatch, and make their way, as best they can, into the larvæ of aquatic insects. In these they live for a time, but presently they become quiet and, enclosed by a thin shell, they remain imbedded in the tissues of the insect larvæ. If such a larva is swallowed by a fish, as a great many of them are, the shell which encloses the embryo worm is removed by the process of digestion, and thus the young worm set free, when it at once bores its way into the body of the fish, where it lives for some time, but finally becomes again encysted, that is, enclosed in a shell, as at (g) figure 17. Here it lives for several months, but at last it becomes active, breaks through its cell and goes into the intestines, through which it passes into the water. The development is now rapid and the change great. The length increases greatly, and at length they reach the form shown as (k) figure 17, and in some unaccountable manner, the worms make their way out of the water and get into the abdomens of locusts, beetles, or some other insects. In this stage they do their service to man by weakening their host and thus making it less injurious. They live in the insects for some weeks, and finally go back into the water, and there lay their numerous eggs and complete their lives.

Remedies. There are many remedies for locusts, some of which have been found quite satisfactory. When it can be done the most obvious method of checking any leaf-eating insect is poisoning the leaves which they are likely to eat. Many plants can be thus protected from the assaults of locusts by using either Paris green or, where this is objectionable, kerosene emulsion, but such a remedy is often impracticable, as when fields of grass or grain are attacked. As a preventive measure fall plowing has been found useful. The egg masses seen in figure 12 remain in the ground during fall and winter, and thorough stirring of the ground destroys many of these and others are exposed to birds, the weather, etc., and thus destroyed. If they are dried, as when they remain for a length of time in the open air, or if buried deeply, as by deep plowing, the eggs perish. If a growing crop is to be rid of the pests, it can be more or less satisfactorily done by various appliances.

A writer reports in one of the papers that he has been very successful in destroying grass eating insects by dragging over the grass a large sheet of iron coated with tar, by which they are caught. A trap recommended in the Report U. S. Department Agriculture for 1883, is described as follows:

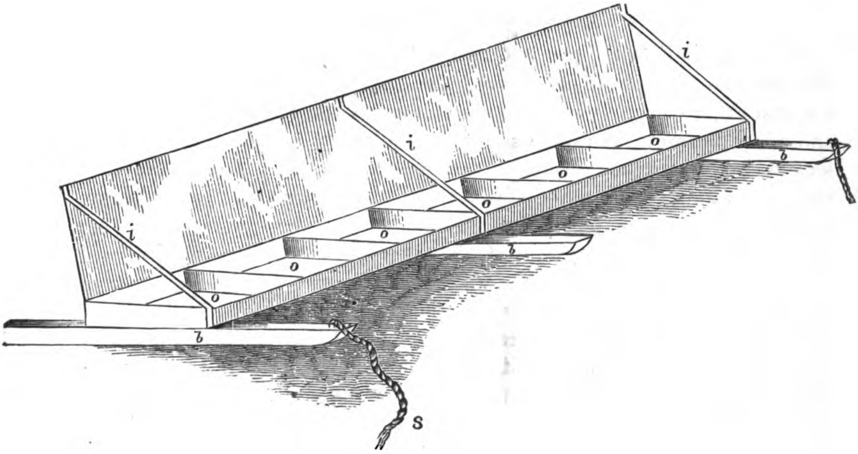


Fig. 18. Coal oil pan for catching locusts. From Rep. U. S Dept. Agriculture, 1883.

"Take a common board from 12 to 15 feet in length for the foundation or bed-piece. Make a tin trough 4 inches deep, 6 inches wide and as long as required. Divide the trough into partitions by means of strips of tin, so that each partition is a foot long, (see figure 18) to avoid the spilling of oil. Back of this place a strip of tin 16 inches wide and as long as the trough. The back must be firmly secured by braces running down to the front edge of the board. Three are shown in the figure. Under all this place three wooden runners three feet long and shod with iron for the trough to ride on. Fill the pan half full of water and then add a small quantity of kerosene sufficient to cover the water. A horse may be hitched to the machine by fastening a rope to the outside runners. The lightness of the machine will allow its being used on any crops."

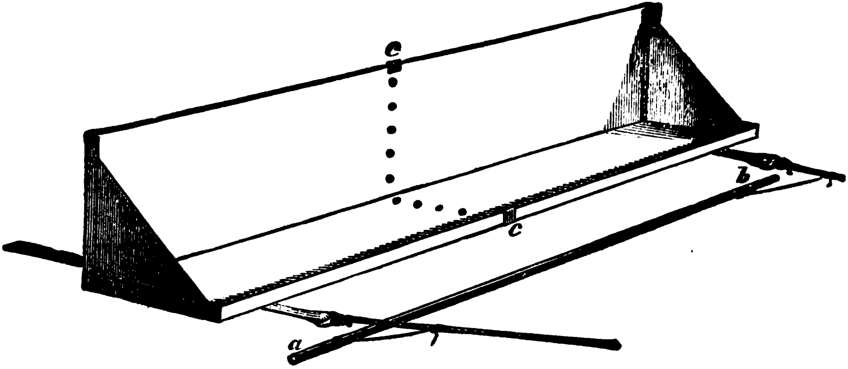


Fig. 19. Iron pan for oil. Used for catching locusts.

A cheaper and smaller pan is shown in figure 19. This is made of sheet iron and may be made of any desired size. As used in the west, this form was made 8 feet long, 11 inches wide at the bottom, 12 inches high behind and 1 inch in front. A runner set on at each end to each of which the cord for draught is attached makes a serviceable machine. It has proved a very useful trap. "We have known from 7 to 12 bushels of young locusts caught with one such pan in an afternoon." Of course water with oil on top is to be placed in the pan as in the other form. Oil alone may be used if it seems to work better, but the water saves the use of quite a quantity of oil. Those who are interested in this subject will find much of value in the First Report of the United States Entomological Commission on the Rocky Mountain locust, or if this is not accessible a much briefer account in the Report of U. S. Department of Agriculture for 1883.

THE ARMY WORM.

Since the first of July (1896) numerous reports of damage done by the army worm have come from the central and southern parts of the state.

Considerable damage was done to oats, barley, corn and some other crops during the month of July. On the 14th of July I examined some fields on the farm of Mr. J. W. Wright, at Chimney Point. Here the first appearance of the worms was on ten acres of barley, where they devoured much of the foliage, but, as the grain was well headed and nearly ready to cut, they did no very great damage. From this, however, they soon migrated to an adjoining field of fodder corn, which was some two feet high. Much of this, at the time of my visit, was completely destroyed, and, although it was midday, warm and bright, the worms were active and feeding, sheltered more or less by the leaves of the corn, inside of which they were found. Mr. Wright had already checked the progress of the worms in a part of the field by using Paris green. At this time many of the worms were fully grown, though many were not. In the neighborhood of Bellows Falls, Fair Haven, Woodstock, Springfield, Waterbury, Burlington and other places the worms appeared, doing more damage to oats than to any other crop, according to the reports. In consequence of these injuries, Newspaper Bulletin 13 was issued as soon as practicable, so that prompt measures for keeping the insect in check might be taken. As in this bulletin no illustrations were possible, it will be best perhaps to repeat in substance what was given therein, with additional information and illustration. A very full account, the best that has been published, may be found in the Third Report U. S. Entomological Commission. Briefer accounts are given in Report of the U. S. Department of Agriculture, 1881–82, and in a special circular, No. 4, Second Series, U. S. Department of Agriculture.

The army worm is a long known and very widely distributed insect. It is comparatively unknown in many localities where it has long been common, because it lives naturally in grass, hidden among the tufts, and when young is light colored and so closely resembles its food plant that it is not noticed. Moreover, ordinarily it does not bring itself into prominence by its devastations, but once in a while, because of especially favorable conditions, it increases with great rapidity and seems to come upon a town very suddenly, and the farmers wonder where it came from and how it came. Fortunately for the farmer it is beset by so many natural enemies, and is so seriously affected by unfavorable climatic conditions that a large proportion of the eggs deposited do not hatch, or if they do the larvæ perish soon after hatching. Hence, though always to be found by searching in proper places in most parts of the United States, the army worm is not generally noticed, because its numbers are kept within bounds, and it does not leave the meadows in which it finds sufficient food. Only when, through exceptional increase as just indicated, the food supply is brought low, do the worms leave the grass and attack grain, or corn, or perhaps potatoes, and cause sufficient injury to attract attention.

The present year is one of these times. It is now many years since any important damage has been done by the army worm in Vermont, and this year, while some farmers have lost a greater or less portion of their crop, the mischief seems to be local, confined within small areas here and there, particularly in and about the towns named on a preceding page, and some others, rather than a general plague. Nor do we need to cherish gloomy forebodings as to the ravages of the worms next year, for, while I should not wish to make any positive and absolute statement, I do not think, judging from its past history, that there is much probability that the army worm will be as abundant next year as it is this, even if left to itself, and certainly not if those whose fields are infested are careful to destroy the pest so far as they can.

It is interesting that the earliest account of the depredations of the army worm that I have found is one given by Rev. Grant Powers, in his "History of Coos County," in which is a description of the ravages of what appears to be this insect in New Hampshire, Vermont and Massachusetts in the year 1770. According to the statements made by Mr. Powers the devastation throughout the Connecticut River Valley was very great. Dr. Riley agrees with Dr. Fitch that there was an outbreak of army worms in New England in 1743, but I have not been able to find this account.

Since these earlier times, the army worm has, at intervals of greater or less duration, ravaged the fields in New England, but in general, so far as I can discover, it has been less numerous in Vermont, and therefore less destructive, than in adjoining states, and it is probable that it will never find the conditions here as favorable as in other and more southern regions. Still it would be very unwise to neglect all plans for its destruction which may be suggested, and this year especially it is important that it be destroyed so far as possible wherever it appears in large numbers. Under ordinary conditions of climate, etc., as experience abundantly proves, the army worm does not appear in injurious numbers, but during a dry season more eggs than usual will hatch, and either this season or the following the insects are likely to appear in larger numbers than usual. Farmers may, therefore, well be on the lookout at such times, not only for this, but other insects, since many injurious species increase under the same or similar conditions. Under stress of hunger the army worm will eat anything organic, but in all ordinary cases their favorite food plants are grasses of various sorts, wheat, oats and corn. Rye, barley and millet they do not so readily attack, though they do sometimes devour these. Usually they do not molest clover, but sometimes they seem to prefer it to other plants. In their habits as well as appearance they resemble some of the cut-worms to which indeed they are near of kin. They most commonly, like cut-worms, feed at night or during cloudy days, and avoid bright light and yet sometimes, as I have stated, they may be found feeding at noon on a clear summer day. The life history of the army worm is as follows: The eggs are spherical white bodies, figure 23, (*g*) natural size, (*h*) enlarged They are laid, most commonly, on a blade of grass, along the inside of the base where the leaf is folded, or inside of the sheath at the base of the leaf. But they are laid in many other localities. Dr. Riley says: " The observations of the present spring have satisfactorily proved that early in the season the moths oviposit by preference in the cut straw of old stacks, in haystacks, and even in old fodder stacks or corn stalks. Old bits of corn stalks upon the surface of the ground in pastures have been repeatedly found * * * * with hundreds of eggs thrust under the outer sheath." When such places are not convenient, however, the eggs may be laid on growing grain or grass, or indeed on any plants conveniently situated. The eggs hatch, according to the warmth of the season, in from one to two weeks, probably, in Vermont, in not less than two weeks. When first hatched the little worms are very light colored and feed only at night or during quite cloudy days, going into hiding when the sun shines. The duration of the worm or larva stage varies in different localities from four to five weeks, or in southern stations it may complete its growth in less than four weeks. When fully grown the worm has the appearance shown in figure 20. It is, as shown, a smooth striped worm about an inch and a half long, of a general dark color on the back and lighter, owing to light stripes, on the sides, while the under side is greenish and has the appearance of being wet. In specimens collected on corn this season, there is considerable variation in the colors, some being much darker than others. Seen under a magnifying glass the surface of the body is thickly mottled. The stripes are quite numerous and are in general as follows: (Some of these markings can be seen in the figure.) Along the lower part of the side, next to the shining, greenish underside and legs, is a very narrow white line, then a band of mottled yellow and red, then a clear, narrow, white line, then a black band which is very plainly seen in the figure, then a white line, then a band of yellowish, then a white line, then a black line, then covering the middle of the back, a band of grayish next the black line last named from which the color shades to almost black on top, In some specimens there is a broken white line running through the middle of the back, but in many cases this is very indistinct, though it is seen in almost all quite plainly just behind the head. As the figure well shows, there are three pairs of true legs on the three first segments, then a little distance behind these, four pairs of stouter false legs, and on the last joint a fifth pair of false legs, making sixteen legs in all. The head is smooth, polished and marked on the sides by a sort of irregular network of brown lines, and from each corner of the mouth there extends a dark line, which, running upwards and inwards on each side, meets its fellow at the top of the head, enclosing thus a triangular space. I think that with this description and figure it will not be difficult to identify the worms when they appear.

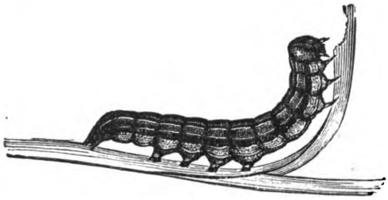


Fig. 20. Full grown army worm.

The worm lives three or four weeks, from egg to maturity, when it goes into the ground, to change to the pupa form, figure 21. In this condition it remains about two weeks, when the perfect insect or moth appears. This moth is not easily described, so that it could be recognized, and this is less necessary to any one except entomologists, since it is chiefly in the larva or worm stage that the farmer is concerned with it. Figure 22 shows the moth, natural size. The color of the front wings is a fawn, or reddish gray, thickly dotted with black specks. By closely examining the figure two rather indistinct spots, which are of a reddish color, may be seen side by side near the upper edge of each wing. The hind wings are thin and grayish. The moths do no harm to vegetation. They fly by night or late in the afternoon. Most commonly the army worm hibernates in the larvæ state but, especially in the south, it also spends the winter in the moth state.

Fig. 21. Pupa of army worm, natural size.

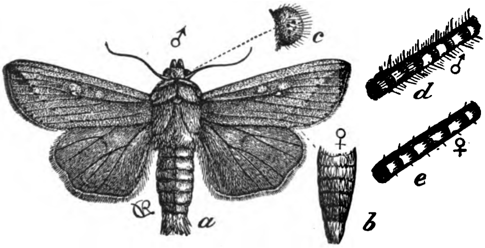


Fig. 22. *Leucania unipuncta.* (a) Moth, male (b) Abdomen of female. (c) Eye, enlarged (d) Part of antenna of male. (e) Part of antenna of female. From Third Report U. S. Ent. Commission, as are all the figures of the army worm here shown.

The number of broods or generations during a season is variable. In warmer parts of the territory in which it occurs, there are reported five, or even six; three appears to be the more common number, but I doubt whether in Vermont and other northern localities there are more than two. In any case there is never more than one brood that is very destructive. It is possible we have, in favorable years, three broods here, for the worms at the present writing, (July 25,) are going into the ground in some places. This would give ample time for pupation, say two weeks, soon after which the moths would lay their eggs, and, these hatching in at most two weeks more, or by the last of August, there would probably be time for full development of the worms before frost. If, as is most probable, the brood which has been

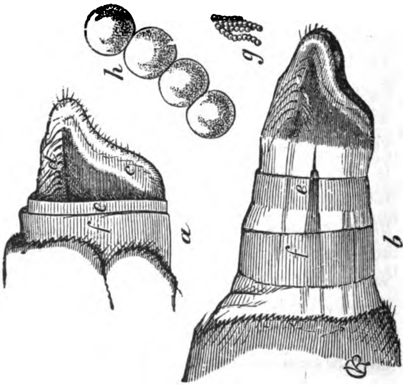


Fig. 23. *Ovipositor of Leucania.* (a) End of abdomen, ovipositor in normal position. (b) Ovipositor extended. (h) Eggs, all much enlarged. (g) Eggs, natural size.

attracting so much attention is the second, we should have three broods. I do not believe, however, that usually there are more than two, and in cold seasons there may be but one.

Remedies. The army worm has a great many natural enemies. Poultry and birds devour many. The bobolink is very useful in this way. Frogs and toads eat many, and it has a small army of insect foes. The beetle shown in figure 17, and all other predaceous beetles devour many and it has many parasites. The tiger beetles, several species of which are shown in figure 24, attack and devour many injurious insects, among them the army worm. These brilliant beetles, which may be seen flying about sunny paths during the summer, are very valuable friends of the farmer.

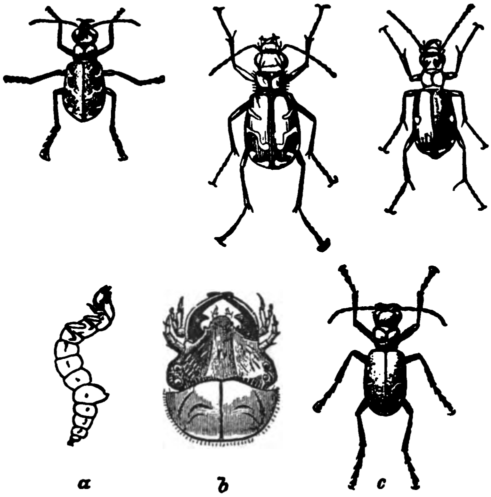


Fig. 24. Tiger beetles of different species. (a) One of the grubs or larvae. (b) Head enlarged, showing jaws.

Several species of tachina flies attack the army worm. The general appearance of these flies may be known by examining figure 25, which illustrates an allied species very similar to those commonly parasitic on the army worm.

These flies are often quite numerous. The female lays her eggs on the army worm, just back of the head, where they soon hatch, and the little maggots (Fig. 25) live on their host to its destruction.

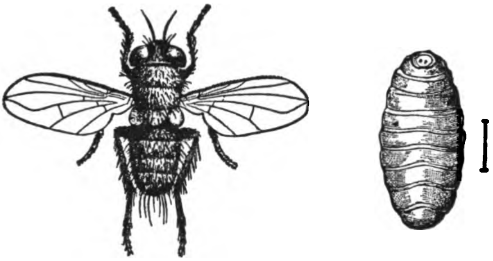


Fig. 25. Tachina fly. **Adult larva.**

These insect enemies of injurious insects, and, therefore, friends and allies of the farmer who is fighting them, are of inestimable value, for they work without injury to crops and in ways which cannot be imitated by man and, as we have noticed, do really accomplish very much, so much that we should often be quite in despair of making headway without them.

After a growing crop is really infested by army worms they are the chief hope of the owner unless the crop be corn, when the use of Paris green, or London purple, which may always be used instead, will destroy many if not all. It is much better to keep the worms out of a field than to try to destroy them when once in.

In most of the reports which have come to the Station, the writer has mentioned the fact that the worms were confined to a more or less limited area, and this is usually the case whenever an outbreak of the worms appears. Everywhere, at first, the depredation is restricted to a single field, or a narrow belt through several fields. From this fact it is evident that the best method of beginning an attack upon them is to confine them where they are that they may not spread to other fields; then, if the fields in which they first appear are bearing crops which, like corn, can be preserved, the evil may be soon averted.

Very old remedies are, ditching to prevent migration from one field to another, and rolling and roping. Trapping with the aid of coal tar, kerosene, etc., and poisoning are newer and often more satisfactory remedies. In the old work of Mr. Powers, to which attention has been called, the use of a rope is mentioned, and this has since been many times tried and often, though not always, it is successful. It is practicable only where the field is not too large, the crop, as wheat or barley, well along in heading, the leaves mostly eaten off and the worms nearly mature. Under these conditions, when two men take hold of the ends of a long rope and draw it across the standing grain, the recoil of the stalk as the rope releases it, throws the worms to the ground, when many of them will not be able to climb the nearly or quite leafless stalks, and will thus perish, though the process may need to be repeated soon afterwards.

A ditch dug around an infested field to keep the worms from migrating, or about an untouched field to keep them out, is sometimes very serviceable and sometimes of very little use. A ditch with smooth, hard sides, is no barrier, but if the sides can be kept friable and crumbling, the worms do not find it easy to pass over it, and, if along the bottom of such a ditch a small band of tar can be placed, many worms will be caught and can easily be destroyed. Or if more convenient a belt of meal, bran or flour, poisoned with Paris green, may be laid along the bottom of the ditch, that any worms attempting to cross may be poisoned. It should be remembered always that it does not so much matter as to the size, width and depth, of the ditch as it does whether the sides, or at any rate the side next to the field to be protected, be loose and crumbling. If it is not convenient to plow a furrow, or otherwise make a ditch, fields can often be protected by a belt two or three feet wide, in which the grain or grass is well poisoned by either dusting with a mixture of thirty parts of plaster and one of Paris green, or sprinkling with a mixture consisting of a teaspoonful of the poison in a pail of water.

Attempting to destroy the worms by running a heavy roller over them has been tried, but not usually with very good results. A very efficient barrier is a line of six inch fence boards, or wider if at hand, well covered with tar and set up on edge, or if the soil is hard and smooth and the worms not very numerous, a line of tar, a few inches wide, can be laid right on the ground between fields.

A most important and efficient remedy, or rather means of preventing the worms from becoming so numerous as to be troublesome, is the burning over all fields which have been infested, after the crop has been gathered. All stubble, rubbish, weeds about the borders of the field, and whatever else may harbor the worm in any of the stages in which it may be, should be well burned. This practice has been abundantly justified by the experience of many who have tried it. It is better to delay the burning as late in the fall as may be, or whenever the field will most readily burn over. Sometimes, if delayed too long, the undergrowth of weeds, etc., becomes so rank that fire will not run over the field. Of course it must be done before snow comes.

As we have seen, the army worm seldom appears in large numbers during consecutive seasons and yet it does sometimes. It is also much more likely to appear abundantly after a very dry season, as are most insect pests. The character of the season during which it is numerous does not seem to be of so much consequence as does that of the preceding season. I do not know that an outbreak of the worms ever follows a wet season, but it may occur during such a season if that which preceded was dry. It may be noticed that there are two army worms, one of which, the common one, does not eat the heads of grain, at least not ordinarily, and one which does. This latter is of a distinct species, and though similar to the other is lighter, and with less numerous stripes. A single specimen of a larva which I think is of this species and which had been devouring the tassels of corn was brought to me from the southern part of the state. So far as I know this insect is not abundant anywhere in Vermont.

BUD MOTH.

Several specimens of the tied up leaves and buds infested by the Bud moth, *Tmetocera ocellana* were sent in during the past spring. I do not know that thus far this most troublesome insect has appeared in abundance, but it has proved to be so serious a pest in New York during the past few years and is itself so difficult to deal with that we may well look upon its appearance with apprehension. The "tying together of the opening leaves and flowers and the brown appearance of many of them, are the most characteristic indications of the presence of the insect." Thus far few remedies have been found. Hand picking when the presence of the worms is made evident by the above mentioned signs and destroying all infested clusters of leaves and buds seems on the whole most likely to be useful, though Mr. Slingerland, who has made a special study of this insect, says: "We believe the pest can be reached with an arsenical spray applied frequently and thoroughly. It will necessitate at least two thorough applications *before the flowers open.* If possible keep the swelling and opening buds coated with Paris green so that the little caterpillar's first meal in the spring will be a poisonous one."

CHINCH BUG.

Last year several reports came from Addison County of damage from the *Chinch bug*, and on inquiry it was found that for three years or more these insects have done more or less damage to the crops in that county. So far as can be ascertained the pest is confined to Addison County. The limits of this report do not allow of any extended discussion of this insect, nor have replies to inquiries sent out been returned so fully as it is hoped they will be. Therefore a full account of the Chinch bug will be deferred until a later publication. Only a few hints as to remedies can be given here. In the first place it is well to notice that a wet season is especially fatal to this insect, so that after such a season it is very unlikely that it will appear in any considerable numbers, but after a dry season, in infested localities, it is almost sure to be troublesome. As this insect hibernates in the mature state, and in the fall hides in a great variety of places, among others, in and about stalks of corn, rubbish, straw stacks, weeds about corners and edge of fields, many may be destroyed by burning all such shelters, or as many as possible late in the fall. This practice of burning all stubble, refuse, corn stalks, etc., late in the fall has already been repeatedly recommended in this report, and too much emphasis can hardly be placed upon it. So many troublesome insects can be, at least in some measure, reached by such burning and destroyed, that it is to be regarded as one of our most important aids in checking the ravages of injurious insects. The migration of the Chinch bug from infested fields to others may be prevented by much the same measures as have been mentioned in connection with the army worm, except those which make use of poison, which would be of no use in case of the Chinch bug, since this insect does not eat the leaves, but sucks the juices of plants and hence is not affected by poison on the surface. In the use of tar, ditching is not necessary, for these insects are so small, that at least whenever the ground is tolerably smooth between fields, a strip of tar poured along the surface of the ground from the spout of a kettle is sufficient, if the tar is renewed every day or two, and the captured bugs taken care of. If after a field in which Chinch bugs have been found is burned over, it is plowed and harrowed, much will be done to exterminate the pest. Kerosene emulsion, where it can be used, is found quite efficacious. Especially if the crop to be treated is corn, which Chinch bugs are very likely to infest, if in the region, the emulsion can readily be used, either thrown over the corn with a large syringe or sprinkling machine, or even sprinkled on with a watering pot.

CUT WORMS.

During the year numerous inquiries have been made concerning Cut worms. As these have been somewhat fully considered in the seventh report of the station I may be allowed to refer those interested to that report. However, as it is and has for some time been out of print it has been thought advisable to introduce here the illustrations used in the above account, that any who desire may be able to identify such specimens as they may find, or to know whether the pest they would be rid of is a Cut worm or some other insect. All Cut worms are larvae of moths, and the relation between the worm and the moth is seen in the accompanying figures.

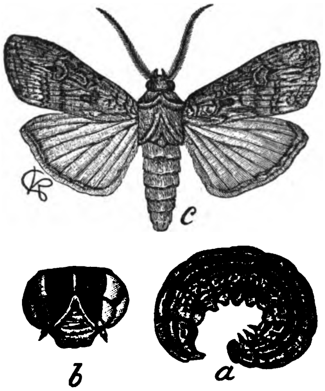


Fig. 26. Agrotis ypsilon, (c) moth, (a) larva. Greasy cut worm.

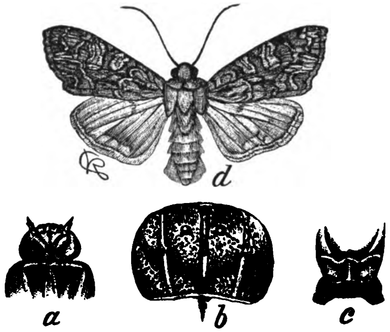


Fig. 27. Mamestra subjuncta, (a) head of larva, (b) middle joint, (c) posterior end of larva, (d) moth.

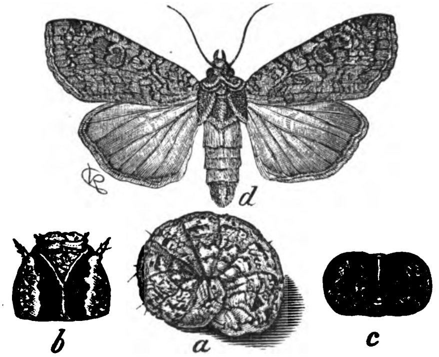


Fig. 28. Peridroma saucia, (a) larva, (b) head of larva (c) middle joint, (d) moth. Varigated cut worm.

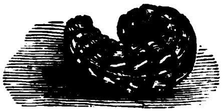


Fig. 29. Nocturna clandestina. Moth and larva. W. marked cut worm.

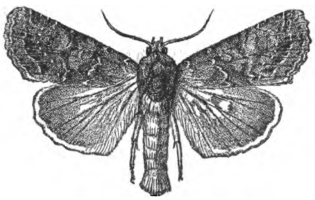


Fig. 30. Xylophasia devastatrix.

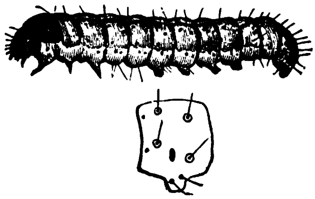


Fig. 31. Larva of Xylophasia devastatrix. Glassy cut worm.

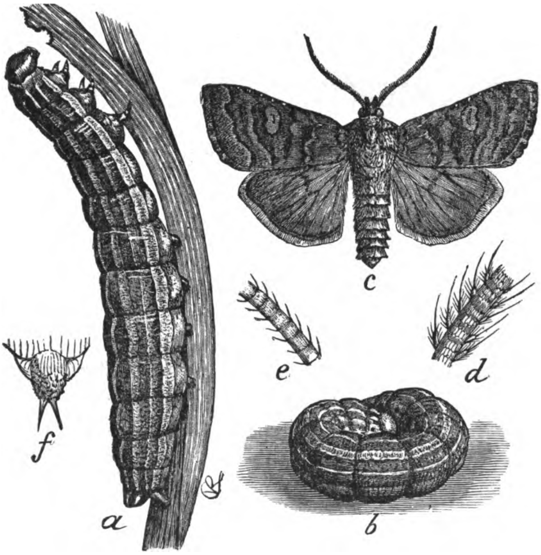


Fig. 32. *Nephelodes minians;* Bronze cut worm, (a) larva feeding, (b) larva curled, (c) moth.

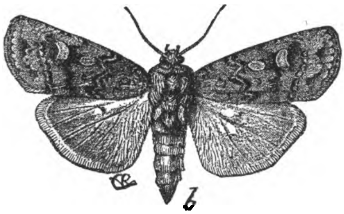


Fig. 33. *Carneodes messoria.* Moth of dark sided cut worm.

For remedies the reader is referred to the article mentioned. It must here suffice to say that many may be trapped by scattering at night balls of poisoned clover about infested fields. In case of young plants that are to be transplanted, it is best to dip each as it is set out into a mixture of one-fourth pound hellebore and ten quarts of water, or Paris green and water could be used.

EXPERIMENTS IN BEE KEEPING.

BY O. J. LOWREY,

CHAIRMAN OF COMMITTEE OF VERMONT BEEKEEPERS' ASSOCIATION.

Experimental work with bees was continued in 1895 at the Station apiary with results as follows:

(1.) *Relative value of different sized frames, especially divisible brood chambers, for building up in the spring and for the production (amount and quality) of honey.* The station bees came from several sources, but are now all packed in dry sawdust or fine cut hay. Thus far no perceptible difference has been noted in the different sized frames in the matter of wintering or building up in the spring with like management. The amount of honey secured by the use of a contracted brood chamber after swarming is notably greater. Further data will be obtained on this line in coming years.

(2.) *Stimulative spring feeding.* In some sections spring feeding is done in order to stimulate brood rearing and to increase the size of the colonies before the white honey flow (June 10 in Vermont).

The results of tests of this practice indicate that it is positively injurious to thus stimulate bees in early spring in this northern climate. Such spring feeding should not be allowed until enough young bees have hatched in the hives to maintain the heat of the colony. Should it become necessary to do any feeding before that time, combs of honey or combs filled with sugar syrup may be placed in the brood chamber where the bees can have access to them. Any management that will cause bees to become active during cool, windy spring weather is liable to bring about spring dwindling, which is very demoralizing to bees, by lessening the working force necessary to preserve the welfare of the colony until the young bees, with greater vitality, are able to supply the hive.

After the weather becomes settled and warm, stimulative feeding may often prove beneficial, particularly if there promises to be a scarcity of honey in the field. It takes about twenty-one days to produce a worker bee from the egg and twelve to fourteen days from the time the young worker bee emerges from the cell before it is ready to go into the field to gather honey. We should strive to have all colonies as strong as possible and ready for the harvest and to know the resources for honey in our immediate locality.

(3.) *Will bees use bits and scraps of wax in comb construction during the honey flow?*

This test was made by Mr. J. E. Crane of Middlebury, a large and successful honey producer, who reports that "a handful of fine wax scrapings from a cake of yellow wax was placed on top of some fairly well-filled sections with combs partly capped, covered with a screen of wire cloth, and darkened. The bees came up through the sections at once and pounced upon the wax." At the first visit "after thirty-six or thirty-eight hours I found the wax gone, the combs showing a mottled appearance, the capping being white and yellow."

(4.) *The Langdon Non-Swarmer.* (Repetition of No. 4, 8th Report, pp. 139–140). The repetition of this test was referred to the writer. The Langdon Non-Swarmer was placed in the home yard, containing one hundred colonies of bees. The colonies selected for the test were Italians which had had no preparation or desire to swarm noticeable on close inspection. The honey flow in this section this season was very slow. The directions were fully carried out and the test of last season, with report thereon, was fully verified. The apparatus proved a failure so far as preventing any desire to swarm.

(5.) *Can swarming be prevented by removing all drones and drone brood from the hive once in ten days?*

On May 27 perforated zinc was placed in front of the hive so that no drones could gain access. All drone brood and drone larva were destroyed once in ten days. Capped queen cells were found July 5th and a swarm was cast six days later. Apparently bees will swarm without drones in the hive, although a large number of drones might hasten swarming.

(6.) *Different work and honey quality on different comb foundations for section honey.*

Three samples of comb foundation were used in this test, two being made on the roller mills by J. D. Goodrich of Hardwick, Vt., and the A. I. Root Co. of Medina, O., and one on the Given press, by R. H. Holmes of Shoreham, Vt. The former ran from twelve to thirteen feet to the pound.

The sections were placed in the clamp so each could have an equal chance by alternating the sections All sections were numbered and booked so each could be known. No difference was noticeable in the work of the bees. The honeys made on the different foundations were taken before the members of the Vermont Beekeepers' Association at their meeting in January, 1896, and a committee was appointed to examine and test the same and see if they could tell which was made on the Given press foundation and which on the roller mill. The committee was unable to tell or to discover any difference in the quality of the honeys sampled, nor was there a perceptible difference in the septum of the cells.

(7.) *A new hive.* (Experiment No. 11.) Two hives were made with apartments in front of the brood chamber, containing two wide frames, each holding eight one-pound boxes. These hives had a super covering the entire brood nest, holding thirty-six one-pound boxes. They also contained eight Langstroth frames and one division board. A partition between the brood nest and this front chamber was made of half-inch lumber with strips of perforated metal to allow the bees to pass and re-pass from the brood box to the sections. No obstruction was placed over the entrance of the hive. These hives proved very satisfactory during the season but plants producing honey vary so much one year with another that a number of years may be necessary to decide whether a hive of this pattern has any merits for the practical apiarist.

Thus far the Station bee house has given satisfaction. The colonies wintering in the house have come out in the spring in better shape for the past two years than those which wintered out of doors on their summer stands, in chaff-packed hives.

During the season of 1895 an average of thirty-eight pounds of comb honey per colony was secured from eighteen colonies and the number was increased to twenty-six.

THE METHOD OF LEAST SQUARES

AS A MEANS OF DETERMINING THE

MONEY VALUES OF COMMERCIAL FEEDS.

By J. L. Hills, J. W. Boyce and C. H. Jones.

It is well known that the nutritive values of various commercial feeding stuffs differ widely, and that their market prices are subject to fluctuations which are often out of proportion to their worth as feeds. These conditions naturally suggest the need of some common standard, some valuation system in order to favor economical buying. For many years a valuation system has been successfully applied to the analysis of commercial fertilizers, and it is usually looked upon as a necessary and, paradoxically, a beneficial evil.

Writers differ, however, as to the wisdom of applying such a system to commercial feeding stuffs. Its advocates urge the points noted in our opening sentence, and the usefulness of valuations as applied to other agricultural products. Its opponents lay stress upon (1) the difference between agricultural and commercial values, which the farmer too seldom appreciates; (2) the misleading and frequently practically absurd, though mathematically correct, valuations placed upon certain materials; (3) the paramount importance of protein as compared with other nutrients in materials bought, a preeminence often unrecognized in the results of mathematical processes; and (4) the danger which lies in the substitution, in the minds of farmers, of mechanical processes or mathematical results for intelligent comprehension of, and application of general principles to specific cases.

Without entering further into the merits of the discussion, we would present, as of possible interest, the following results of a study of the applicability of the mathematical process known as "The Method of Least Squares" to the solution of the problem of feed valuations at present Vermont market prices.

The matter will be discussed under the following heads:

I. Systems of valuation in use.

II. "Least Square" data, and results hitherto obtained at various stations.

III. "Least Squares" applied to Vermont feeding stuffs and prices, 1895-96.

I. SYSTEMS OF VALUATION IN USE.

Two systems are used in determining fodder valuations.

One seeks to establish a ratio between the values of various food ingredients, based upon market prices and analyses. As a rule, simple mathematics, but sometimes complex reasoning, are used in formulating the ratio.

The other system determines the relative values of the ingredients by means of the mathematical process known as the "Method of Least Squares."

It has long been recognized that the first method is open to objections. In fact different writers propose different ratios. For instance, according to Woll,* the ratios 1 : 4 : 5 and 1 : 4 : 3.1 were proposed by two eminent German authorities for nitrogen-free extract, fat and protein, in 1882, while 1 : 4 : 6, 1 : 2 : 6 and 1 : 5 : 5 were proposed by three other investigators for 1881, 1880 and 1883, respectively.

Some calculate from total crude nutrients, some from the digestible components only. Until agreement can be reached among those proposing ratios, the figures are likely to be more confusing than helpful.

In 1878, a committee of German Experiment Station workers carefully studied the question and for the first time "Least Squares" was proposed as a method of calculating the average price per pound of protein, fat and carbohydrates in cattle feeds.

The report of Dr. Kœnig, chairman, appears in the *Landwirthschaftliche Jahrbucher*, 1880, pp. 805–836.

The committee recommended and stated:

1. That total nutrients, as determined by chemical analysis (Weende method) should be used, instead of the digestible portions, for the following reasons:

(*a*) These only can be shown by chemical analysis, or be guaranteed by dealers.

(*b*) Digestive coefficients are not yet made for all feeds,

(*c*) Are uncertain and fluctuating,

(*d*) Are particularly affected by rumination,

(*e*) And by the accompanying feeds.

2. That only such fodder stuffs should be used as a basis of calculating values as are generally and exclusively in use for animal feeding.

3. That average analyses should be used.

4. That the "Method of Least Squares" should be made the basis of computation, it being, in their judgment, the only method applicable.

5. That the "Method of Least Squares" gave trustworthy results only when the basal feeds were so chosen that no one nutrient received undue preponderance; or, in other words, the choice of feeding stuffs used as a basis of calculation must contain a nearly equal number of materials pre-

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*Agl. Sci., VI., p. 108.

eminently rich in either protein and (or) fat or carbohydrates. Otherwise the unduly preponderating ingredient would receive a proportionately high valuation and the result be correspondingly less trustworthy. Also that the values were more nearly correct in proportion to the number of well chosen feeds included in the basal list.

6. That while some feeds of each sort (nitrogenous, fatty, starchy) might show a high value, and some a low one, as compared with market prices, yet, barring fancy prices (*affektions preis*), the averages might be expected to be closely alike.

7. That valuations of given feeds being determined, by the use of pound values as established by "Least Squares," relative digestibility and special adaptation to special needs should be considered in choice for purchase.

8. That owing to fluctuations in market prices, recalculations of values should be made periodically.

9. That when the food contents of a feeding stuff are guaranteed, the comparison between guarantee and delivery may be expressed in terms of cash, and shortage, if any, made good by definite rule.

II. LEAST SQUARE DATA AND RESULTS AT OTHER STATIONS.

The committee making the report summarized in the last section, used seventeen feeds as a basis of computation, and obtained the following values per kilo, in fractions of a mark, for protein, fat and carbohydrates. The corresponding ratios are also tabulated:

	PROTEIN.	FAT.	CARBOHYDRATES.	PROTEIN.	FAT.	CARBOHYDRATES.
	mk.	mk.	mk.			
Average five years, 1874-78...	0.335	0.332	0.109	3	3	1
1878-79...	0.301	0.316	0.086	3.5	3.7	1
Fall 1879........................	0.270	0.244	0.121	2.2	2.2	1

Later in *Zusammens d. Futtermittel 2d Edit.* p. 1049. Kœnig gives ratios for 1882-85 and 1886-89 as 2.3 : 1.3 : 1 and 3 : 2 : 1.

Several American experiment stations have used "Least Squares" in calculating the valuations of feeding stuffs. Very diverse values have been obtained, differing from German figures, which obviously are not applicable to American conditions, and also among themselves. The following table gives a summary of past work in this line at the various stations:

STATION	DATE	BY	REFERENCE.	VALUE IN CENTS PER POUND.			RATIOS.		
				PROREIN	FAT	CARBOHYDRATES	PROTEIN	FAT	CARBOHYDRATES
1 Conn.	1888	Jenkins	Rpt. for 1888, p. 141–144.	1.60	4.2	0.96	1.7	4.4	1
2 "	1890	"	Rpt. for 1890. p. 182	1.40	2.9	1.40	1.0	2.1	1
3 Del.	1889	Penny	2nd Rpt. pp. 157–163....	1.23	4.45	0.52	2.4	8.6	1
4 Ind.	1891	Huston	Bul. 47, p. 146	1.00	2.75	0.63	1.6	4.4	1
5 N. J.	1889	Vorhees	12th Rept. pp. 160–163 ..	0.91	5.91	1.12	0.8	5.3	1
6 Wis.	891	Woll	8th Rept. pp. 212–219 ...	1.52	3.58	0.47	3.2	7.6	1

It will be noted that protein ranges from 0.91 cents to 1.6 cents a pound (1 : 1.8), fat from 2.75 cents to 5.91 cents a pound (1 : 2.1) and carbohydrates from 0.47 cents to 1.40 cents per pound (1 : 3). Or, expressing it in the form of ratios, protein was found to be worth all the way from 0.8 to 3.2 times as much as the carbohydrates, and fats, from 2.1 to 8.6 times as much as carbohydrates. These differences are not surprising when the variations in basal lists and selling prices are noted. For instance, wheat bran sold in Connecticut in 1890 for $25.00, and in Wisconsin a year later for but $12.00, corn meal ranges from $26.00 to $14.00, etc.

The feeds, selling prices and sources of analysis from which the above values were derived are as follows:

(1) Analyses, Rpt. for 1888, pp. 90-94. Feeds and selling prices; cotton seed meal, $27.75; linseed meal (O. P.), $32.25; wheat bran, $20.50; wheat middlings, $22.00; rye bran, $21.00; corn meal, $21.50; gluten meal, $23.00; hominy chops, $21.00; malt sprouts, $17.00; oat middlings, $25.00; rye feed, $20.00.

(2) Analyses, Bul. 11, Office of Expt. Stats. Feeds and selling prices: cotton seed meal, $27.50; linseed meal (O. P.), $28.00; do (N. P.), $26.00; wheat bran $25.00; wheat middlings, $26.00; rye bran, $25.50; corn meal, $26.00; gluten meal, $27.50; hominy chops, $25.00; malt sprouts, $20.00; rye feed, $25.50.

(3) Analyses, 2d Rpt. p. 156. Feeds and selling prices: bran, $14.00; middlings, $15.00; cotton seed meal, $22.00; cob meal, $12.00; corn meal, $14.00; oats, $18.00.

(4) Neither analyses, feeds or selling prices stated.

(5) Analyses, 12th Rpt. pp. 148–155. Feeds and selling prices: corn meal, $25.80; wheat bran, $21.00; wheat middlings, white, $25.60; do. brown, $22.80; linseed meal, $31.00; cotton seed meal, $28.00; rye bran, $19.60; ground oats, $24.20; dried brewers' grains, $19.40; malt sprouts, $17.60.

(6) Analyses, Bul. 11, Office of Expt. Stats. Feeds and selling prices: cotton seed meal, $24.00; linseed meal (O. P.), $22.00; wheat bran, $12.00; wheat middlings, $13.00; rye bran, $12.00; corn meal, $14.00.

It is clear that if a valuation system came in vogue frequent recalculations would have to be made, and, also, that different sections of the country would need different sets of values.

III. "LEAST SQUARES" APPLIED TO VERMONT FEEDING STUFFS AND PRICES, 1895–96.

No report has come to our knowledge of the use of "Least Squares" by an American Experiment Station since 1891. There have been some changes in market prices in New England since that date, and a recalculation appeared to be in order. Accordingly we undertook the calculation of the valuation of commercial feeding stuffs by the "Method of Least Squares," under the market conditions in Vermont for the current year.*

At the outset we were confronted with the difficulty in the choice of feeds for the basal list. These feeds must comply with the two essentials laid down by Dr. Kœnig, viz.: that only such materials should be chosen as were in general yet exclusive use for animal food, and that as nearly as might be even numbers of starchy and proteinous feeds should be used. It was finally thought that these essentials were best complied with by the selection of the following eight materials, which a canvass of the State had shown to be decidedly the most common in use, viz.: cotton seed, linseed and gluten meals, gluten feed, wheat bran and middlings, corn meal and oats. A glance at the analyses, or at the following comparison, shows how well, moreover, the even balance of foods of different character was maintained.

	PROTEIN.	FAT.	CARBOHYDRATES.
Cotton seed, linseed and gluten meals, and gluten feed.	42.3 to 22.7	13.1 to 8	56.0 to 29.2
Wheat bran and middlings, corn meal and oats.	15.6 to 9.2	5.0 to 3.8	70.0 to 62.9

The market prices used were an average of several obtained from different parts of the State.

Applying the "Method of Least Squares" to the feeds and prices in question, the following results were obtained:

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*These calculations were made by Mr. J. W. Boyce as a subject for graduation thesis in the agricultural department of the University of Vermont and State Agricultural College.

AVERAGE ANALYSES AND SELLING PRICES.

FEED.	ANALYSIS TAKEN FROM	NUMBER OF SAMPLES.	WATER.	CRUDE ASH.	CRUDE PROTEIN	CRUDE FIBRE.	NITROGEN FREE EXTRACT.	ETHER EXTRACT.	SELLING PRICE PER TON.
Cotton Seed Meal	Bul. 11, O. E. S.	35	8.2	7 2	42.3	5.6	23.6	13.1	$22.80
Linseed Meal (O P)	" "	21	9.2	5.7	33.0	8.9	35.4	8.0	21.60
Gluten Meal.....	Bul. 43, Vt.	32	8.7	1.3	33.5	1.4	44.1	10.9	20.60
Gluten Feed.....	" "	34	8.0	1.0	22.7	6.7	49.5	12.0	18.00
Wheat Bran ...	Bul. 11, O. E. S.	88	11.9	5.8	15.4	9.0	53.9	4.0	16.00
Wheat Middlings	" "	32	12.1	3.3	15.6	4.6	60.4	4.0	16.80
Corn Meal.......	" "	77	15.0	1.4	9.2	1.9	68.7	3.8	16.60
Oats.............	" "	30	11.0	3.0	11.8	9.3	59.7	5.0	20.00

NORMAL EQUATIONS.

$$52.20\,x + 89.39\,y + 16.74\,z = 183.66$$
$$89.39\,x + 259.48\,y + 30.30\,z = 410.92$$
$$16.74\,x + 30.30\,y + 5.70\,z = 60.32$$

Solving in the usual manner, we find x (protein) = 2.023 cents per lb., y (total carbohydrates) = 0.909 cents per lb., and z (fat) — 0.1908 cents.

In proof of mathematical correctness we would say that the substitution of these values for x, y and z, in the above normal equations, gives the three products correctly. Also, that as the following table shows, the total difference on the eight tons is but three cents.

VALUE OF INGREDIENTS IN BASAL FEEDS.

	PROTEIN.	CARBOHY-DRATES.	FAT.	VALUATION PER TON.	SELLING PRICE PER TON.	VALUATION ∓ SELLING PRICE.
Cotton Seed Meal......	$17.11	$5.31	—$0.50	$21.92	$22.80	—$0.88
Linseed Meal..........	13.35	8.05	— 0.31	21.09	21.60	— 0.51
Gluten Meal...........	13.55	8.27	— 0.41	21.41	20 60	+ 0.81
Gluten Feed	9.18	10.18	— 0.46	18.90	18.00	+ 0.90
Wheat Bran...........	6.23	11.44	— 0.15	17.52	16.00	+ 1.52
Wheat Middlings......	6.31	11.82	— 0.15	17.98	16.80	+ 1.08
Corn Meal.............	3.72	12.84	— 0.14	16.43	16.60	— 0.17
Oats..................	6.77	12.54	— 0.19	17.12	20.00	— 2.88
				$152.37	$152.40	

Several other combinations, consisting of from four to seven of these feeds each, were tried, but in no case could positive values be found for all their nutrients, z (fat) being continually negative. Yet each calculation proved to be mathematically correct.

Omitting oats: Protein, 2.21 cts.; Carbohydrates, 0.82 cts.; fat,—0.47 cts.

Omitting gluten feed: Protein, 2.11 cts.; carbohydrates, 0.92 cts.; fat,—0.46 cts.

Omitting oats, linseed aud gluten meals: Protein, 2.11 cts.; carbohydrates, 0.82 cts.; fat,—0.10 cts.

Adding to the eight feeds used, hominy chop, corn oil cake, Atlas gluten meal, cotton seed bran and oat feed, materials but rarely used in the State, we obtained as values: protein, 1.98 cts.; carbohydrates, 0.94 cts.; fat,—0.70 cts.

By making not unjustifiable modifications in a few selling prices (due to later figures), positive though ridiculous values were obtained as follows: protein, 1.97 cts.; carbohydrates, 0.91 cts.; fat, 0.30 cts.

No value whatever was obtained for z (fat), which resembled in the least those obtained by previous workers.

In reviewing the work of the stations already cited, no fault could be found with the mathematics, or in general, with the reasoning used. The choice of feeds in making up the basal list, however, did not always approve itself to our judgment, and, as in our case, leaving out a single feed radically changed the values obtained. In no case, however, were negative values derived. Thus, for example. Penny (*loc cit*), using cotton seed meal, bran, middlings, cob meal, corn meal and oats, obtained the following values per pound: protein, 1 23 cts.; carbohydrates, 0.52 cts.; fat, 4.45 cts.

Omitting cob meal (which seldom enters into trade in this State), the prices of protein and carbohydrates are increased a quarter, and that of fat halved. The figures then become: protein, 1.54 cts.; carbohydrates, 0.66 cts.; fat, 2.15 cts. Omitting oats, which Penny says "furnish the disturbing factor in this calculation," the cost of protein is increased a third and that of fat is halved, the figures becoming: protein, 1.64 cts.; carbohydrates, 0.56 cts.; fat, 2.08.

Again, Woll (*loc cit*) using cotton seed meal, linseed meal (O. P.), wheat bran, wheat middlings, rye bran and corn meal, obtained the following values: protein, 1.52 cts.; carbohydrates, 0.47 cts.; fat, 3.58 cts.

Omitting rye bran (perhaps the least used feed) the values become: protein, 1.86 cts.; carbohydrates, 0.50 cts.; fat, 2.31 cts.

No other comparisons of this sort were made, but these suffice, together with our own results already given, to cast doubt upon the trustworthiness of values which may be so vastly changed by choice of basal feeds or slight fluctuations in selling prices. Apparently if a valuation system for feeding stuffs is ever seriously contemplated, the basal feed list should be determined as it was in Germany in the case cited, by consensus of opinion and not by individual preference.

This precaution, however, will not obviate the negative value which must sometimes occur, unless unusual feeds are brought into the basal list in order to afford positive values.

Kœnig (*loc cit*, p. 822) calls attention to the danger that the method proposed to the committee by Henneberg* for the determination of values by three unknown quantities may frequently yield negative quantities, but does not intimate that any such danger need be faced with "Least Squares." This condition does not appear to have been met hitherto in the application of the method to feed valuation.

In the article already cited, Kœnig gives excellent reasons why total crude nutrients and not digestible components should be used in computing values. There are, however, strong and obvious arguments on the other side also, and the attempt to get rational values in this manner was made. The coefficients of digestibility as given by Lindsey in Mass. Exp. Stat. Rpt. for 1895 were used for the eight feeds under consideration. The results obtained were: Protein, 2.60 cents; carbohydrates, 1.18 cents; fat, —0.89 cents. It will be noted that the minus sign is again in evidence.

The omission of crude fiber from the calculation using total crude nutrients (which, although the German custom, has not approved itself to the former American writers) did not help matters any.

We are not as yet clear just why a negative value is obtained under present market conditions, and positive values under former conditions. †

Merriman‡ states that "the axioms derived from experience," and which are "the foundation of all the reasoning regarding the question of 'Least Squares,'" are "that small errors are more frequent than large ones, positive and negative errors are equally frequent, and that very large errors do not occur."

Because of insufficiency of data large errors must and do occur, particularly in the matter of selling prices, and because of fluctuations therein. Moreover, the not infrequent entire lack of relation between selling price and feeding value introduces a very disturbing factor.

The present investigation has at least raised the question whether the "Method of Least Squares" is not too delicate, and hence unsuited to the purpose under discussion. This conclusion, which was entirely unforeseen in the outset of our work, we regret the more since we have no method to propose in its place.

The mathematical work in connection with this investigation was done by Mr. J. W. Boyce, of the senior class of the agricultural department, and by Mr. C. H. Jones, assistant chemist. These gentlemen also assisted materially in getting the matter into shape for publication.

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* Landwirthschaft. Jahrbuch 1880, p. 809.

† A private communication from one of the American investigators, who has hitherto published values derived by "Least Squares," states that negative values had been obtained by him in further work with later selling prices.

‡ Text book of Least Squares, p. 15.

DAIRYING.

By J. L. Hills.

Experimental work in dairying has been continued at the Station and, as in years past, it has been made a prominent feature of its work.

Stress has been laid upon this line of investigation not only because dairying is the most prominent feature of Vermont agriculture, but also because the concentration of station effort along comparatively few lines usually results in more helpful work than if its energies are scattered over a wide range of effort.

The completed investigations of the year may be grouped under the following headings:

I. Variations in Milk.
    Summary.
    1. Monthly variations during the period of lactation.
    2. Extreme variations in quality during the period of lactation.
    3. Variations in quality and quantity of milk from year to year.
    4. The quality of the milk of strippers.
    5. When to test a cow for quantity and quality of milk.
    6. Effect of abortion on quantity and quality of milk.
II. Record of the Station Herd for 1894–95.
III. Tests of Dairy Apparatus.
IV. Fast and Slow Milking.
V. Miscellaneous Fodder Crops.
VI. Feeding Tests.
    Summary,
    1. Corn ensilage versus beets.
    2. Corn ensilage versus carrots.
    3. Beets versus carrots.
    4. Corn oil cake versus corn and bran.
    5. Atlas gluten meal versus corn and bran.
    6 Cotton seed bran versus corn and bran.
    7. Experimental error in feeding tests.
    8. Records of the test.

I. VARIATIONS IN MILK.

The conclusions presented herewith are based on something over one hundred lactations of cows of many breeds, diversely fed and in three geographical localties, data published by the New York (Geneva) and Minnesota stations being used in addition to a large amount of our own.

SUMMARY.

I. MONTHLY VARIATIONS DURING THE PERIOD OF LACTATION.

Quality. The average spring cow rapidly betters the quality of her milk, beginning about five months after calving; the summer cow starts in as early as the third month, while the fall cow maintains fairly even quality throughout her lactation period, seldom improving it more than half of one per cent. in fat contents. The per cent. of solids not fat also is most uniform month by month in the milk of the fall cow. The percentage of solids not fat in the milk of spring cows seems to lessen somewhat in the summer time.

Quantity. The average fall cow "holds out" as a rule better than the average spring cow, and, in the records now under discussion, as a rule gave larger yields.

Butter. The gross yields of spring and fall cows in the Vermont herd were the same, but in the New York and Minnesota herds, the average fall cow outstripped the average spring cow.

The Vermont fall cow held up the evenness of butter production better than the spring cow. Little, if any, difference was seen in this respect in the other herds.

2. EXTREME VARIATIONS IN QUALITY DURING THE PERIOD OF LACTATION.

The greatest monthly variation * in the quality of the milk of 115 cows was 3.06% fat, the least 0.33% fat. The widest difference involved a change from 26.4 pounds of milk to 14 pounds of milk to a pound of butter. The average variation was 1.26% fat. The average monthly variation of spring cows was 1.62% fat; of fall cows, 1.08% fat; of summer cows, 1.25% fat. The monthly variation of American Holderness and Devon cows seemed to exceed, and of Shorthorns to be less than those of cows of other breeds. The number of individuals in these breeds, however, was small as compared with the other breeds. Two-thirds of the Vermont and Minnesota herds gave thinnest milk during the first two months, and two-thirds of the New York during the first four months.

Ninety per cent. of the Vermont and Minnesota cows gave their richest milk after the seventh month. Sixty per cent. of the New York cows gave their richest milk before the eighth month. The arbitrary limitation of the New York records to a ten months' lactation may partially explain this.

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* I. e. The difference between the lowest and highest average qualities for a month each.

3. VARIATIONS IN QUALITY AND QUANTITY OF MILK FROM YEAR TO YEAR.

But six of forty-three cows change ten per cent. in quality in successive years. Such slight change as was made was for the better in two-thirds of the cases. Quantity changes are too dependent upon feeding, etc., to admit of deductions being drawn.

4. THE QUALITY OF THE MILK OF STRIPPERS.

The milk given during the last few weeks before going dry is richer in fat and solids not fat, and of a higher specific gravity than the average of the milking period, provided the cow has been in calf for two months or more. This is not so surely true if the cow goes dry when farrow or when but recently served, as shown in seven cases instanced in the body of this article, in three of which exceedingly thin milk, far below the average normally given by the cow, was given just before drying off.

5. WHEN TO TEST A COW FOR QUALITY AND QUANTITY OF MILK.

A large number of comparisons show that the average quality of the milk of the entire year may be found with considerable accuracy by testing two composite samples, taken in either of two ways.

1. Spring cows.—First sample taken 6 weeks after calving, and second, from 6½ to 7½ months after calving.

Summer cows.—First sample taken 8 weeks, and second one, from 6 to 7 months after calving.

Fall cows.—First sample taken from 8 to 10 weeks, and second, from 5½ to 7 months after calving.

2. By analysing two composite samples taken two weeks apart, date of taking in case of spring and fall cows to be 6 months after calving, and in case of summer cows to be 3 to 5 months after calving.

Quite close approximations to truth may be obtained by weighing the milk during four days in the middle of each month and calculating the total yield by multiplication. In forty-three per cent. of the cases, calculation was within two per cent. of truth. Butter yields calculated in this manner and by using two Babcock tests came close enough to the truth for most purposes.

6. EFFECT OF ABORTION ON QUANTITY AND QUALITY OF MILK.

The effect of abortion was found to be:

(*a*) A shrinkage of over one-third in milk yield. (*b*) A gain of one-tenth in quality. (*c*) A shrinkage of nearly one-third in butter yield. (*d*) A more even quality of milk throughout the milking period.

The Sixth annual report contained an article upon variations in milk, the study being based on voluminous records kept for several years, showing the quality and quantity of milk given by the various cows belonging to the station herd.

During the past three years similar and even more extended records have been made and filed, which, in their turn, may contribute something to the solution of the causes and effects of milk variation. In many respects wherever the present study has paralleled the former investigations, the conclusions then drawn are confirmed. In some cases, however, different deductions seem warranted.

Data published by the *New York (Geneva) and †Minnesota stations have been freely drawn upon in the study of variations. These are the only American stations which, to our knowledge, have printed data in such shape as will serve the present purpose.

The data of the Vermont station is based upon 47 separate lactations (mainly of Jerseys and their grades and of Ayrshires), the New York data upon 44 separate lactations (American Holderness, Ayrshire, Devon, Guernsey, Holstein, Jersey and Shorthorn), and the Minnesota data upon 17 separate lactations and cows (Jersey, Guernsey, Shorthorn and their grades, Polled Angus and Grade Holsteins).

At all three stations the milk given by each cow is weighed at each milking. At the Vermont station from two to four (sometimes more) composite samples (six or eight milkings to a sample) are taken monthly from the milk of each cow. At the New York station morning and evening milks for one day per week were separately analysed during the first two months of lactation, after which one day's milk during every alternate week was tested. At the Minnesota station the milk was sampled and tested daily.

I. MONTHLY VARIATIONS DURING THE PERIOD OF LACTATION.

Quality. It is well known that cows usually give their thinnest milk in the early stages of lactation, and better milk as the time approaches for drying off. The comparative evenness in quality during the earlier months of the milking period is not so well understood. This uniformity appears to be common to practically all cows except those calving in the summer.

When, however, the average ‡spring cow passes the half way mark of a lactation of ordinary length, if she is in calf her milk rapidly improves in quality. The summer calving cow, however, seems to show this tendency as early as the third month. But the fall calving cow keeps on the even tenor of her way, perhaps bettering her milk a half of one per cent or such matter from its standard when fresh in milk, but seldom exceeding that amount. This amount of change is usually doubled and sometimes thribbled in the milk of cows calving in the spring or summer.

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*New York Agr. Expt. Stat., Thirteenth Report, pp. 268-451.

†Minn. Agr. Expt. Stat., Annual Report for 1893, pp. 314-320; Bul. No. 35, pp. 41-47.

‡Throughout this article cows calving during March, April, May and June, are regarded as spring cows, while those calving in September, October, November and December, are regarded as fall cows.

It will be noted on reference to the tables on pages 163-66 [the quality given during the second month of lactation being 100 (standard)], that the following extremes were noted:

TIME OF CALVING.	STATION.	NUMBER OF COWS.	EXTREMES.
Spring	Vermont	12	97 to 120
"	New York	13	99 to 139
"	Minnesota	7	100 to 118
Summer	Vermont	8	98 to 118
Fall	Vermont	27	98 to 110
"	New York	25	99 to 105
"	Minnesota	10	97 to 106

The solids not fat likewise run somewhat less evenly in the milk of cows calving in the spring, as shown by the following data taken from the same tables:

TIME OF CALVING.	STATION	NUMBER OF COWS.	EXTREMES.
Spring	Vermont	12	99 to 104
"	New York	13	98 to 107
Summer	Vermont	8	100 to 104
Fall	Vermont	27	100 to 102
"	New York	25	100 to 106

The Minnesota data does not include the total solids.

It is notable that there is close parallelism in the records of solids not fat of the spring calving herds of the two stations. There is a period of marked depression in the percentages of these ingredients in the third, fourth, and fifth months of lactation, which are essentially the summer months. A similar but greater change has been noted by *Van Slyke in his cheese factory work, and by †Babcock in his study of the relation between the per cent. of milk solids and the cheese yield. The analytical data indicated that the casein suffered more than any other of the solids not fat. Both of these investigators believe that prolonged drought and insect depredations were the probable causes for the change in the quality of the milk. Babcock noted, also, that those herds which were grained held up in solids not fat better than those which were insufficiently fed on drought affected pastures.

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*New York Agr. Expt. Stat., Twelfth Report, pp. 347-350.

†Wisconsin Agr. Expt. Stat., Twelfth Report, pp. 1 0-114.

The fat percentages did not appear to be unfavorably affected, nor do they parallel those of the solids not fat in the present cases.

Most of the lactations under discussion occurred in "dry" summers, and it seems not improbable that meteorology and poorer milk are cause and effect.

The changes in solids not fat in the Vermont and New York herds were not as great as those observed in factory work, due perhaps to grain feeding.

Quantity of milk. The average Vermont spring cow made as much milk in the first and fourth months, much more in second and third months (early pasture) and less in all other months than did the average Vermont fall cow. The sums total are nearly the same, while the summer cow made but eighty per cent. as much as those calving in spring or fall. The average New York spring cow fell behind her fall calving mate throughout the lactation. The average Minnesota spring cow kept ahead of the fall cow until the sixth month, and then fell behind. The spring cow kept slightly ahead on the total yield. All three fall herds held out in the quantity of the milk flow particularly well in the fifth, sixth, seventh, eighth and ninth months, when the spring cows were well on the downward grade.

Calling the quantity given during the second month 100, the following table shows the relative percentage of that quantity given during each of the following months from the fifth to the ninth:

Number of Month		5	6	7	8	9
Spring,	Vermont	75	65	60	60	59
"	New York	80	75	68	64	56
"	Minnesota	77	66	62	58	55
	Average	77	69	63	61	57
Fall,	Vermont	94	90	90	87	73
"	New York	85	81	76	68	59
"	Minnesota	77	70	74	77	66
	Average	85	80	80	77	66

It is interesting to note the record of those cows calving in the fall which maintained the milk flow throughout the year. The milk yields of the eighth and ninth months are practically duplicates of those of the fourth and fifth months, which is due to their going out upon fresh pasture.

Quantity of butter. It is not easy to draw deductions from the butter records of the herds now under discussion. They are conflicting. The average Vermont fall cow and, indeed, the summer cow also, held out far better than the cow calving in the spring. Gross yields were about the same, but for evenness of production, the fall cow leads. This is not the case, however, in the New York and Minnesota herds. Fall and spring cows held out equally well, or rather, each dropped off with equal rapidity. If anything the New York spring cow had the advantage in evenness of production, due largely to the rapid increase in quality as the lactation progressed. The gross yield of the average New York fall cow was one-seventh greater than that of her spring calving mate, and that of the Minnesota fall cow was somewhat the greatest. The results published in our Sixth report accord with the present Vermont results. The reason for this discrepancy is not clear.

The following tables give the average figures for the spring, summer, and fall calving cows in each of the three herds, and the totals. The latter represent 32 spring cows, 62 fall cows, and 8 summer cows. Following these are a series of charts, showing on the 100 standard the monthly variations in quantity and quality of milk and quantity of butter fat.

RECORD OF TWELVE SPRING COWS.

(Vermont Station.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow.	732	767	732	626	575	503	462	464	453	400
Average monthly per cent of fat.	4.65	4.79	4.79	4.86	5.01	5.25	5.50	5.71	5.61	5.75
Average monthly per cent of solids not fat	9.38	9.18	9.09	9.06	9.13	9.28	9.40	9.55	9.48	9.57
Average monthly yield of butter fat per cow	34.0	36.7	35.1	30.4	28.8	26.4	25.4	26.5	25.4	23.0
Ratio of monthly milk yields	95	100	95	82	75	65	60	60	59	52
Ratio of monthly per cents of fat	97	100	100	102	105	110	115	119	117	120
Ratio of monthly per cents of solids not fat	102	100	99	98	99	101	102	104	103	104
Ratio of monthly fat yields	93	100	96	83	78	72	69	72	69	63

RECORD OF EIGHT SUMMER CALVING COWS.

(Vermont Station.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow.	559	566	534	501	460	476	451	431	394	355
Average monthly per cent of fat	4.61	4.71	5.05	5.17	5.24	5.30	5.38	5.50	5.54	5.54
Average monthly per cent of solids not fat	9.32	9.21	9.36	9.48	9.40	9.56	9.62	9.59	9.50	9.28
Average monthly yield of butter fat per cow	25.8	26.7	27.0	25.9	24.1	25.2	24.3	23.7	21.8	19.7
Ratio of monthly milk yields	99	100	94	89	81	84	80	76	70	63
Ratio of monthly per cents of fat	98	100	107	110	111	113	115	117	118	118
Ratio of monthly per cents of solids not fat	101	100	102	103	102	104	104	104	103	101
Ratio of monthly fat yields	97	100	101	97	90	93	91	89	82	74

RECORD OF TWENTY-SEVEN FALL COWS.

(Vermont Station.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow.	731	661	647	628	619	599	595	573	483	391
Average monthly per cent of fat..........	4.56	4.62	4.73	4.76	4.82	4.83	4.87	4.91	4.98	5.08
Average monthly per cent of solids not fat..................................	9.25	9.10	9.17	9.26	9.28	9.25	9.22	9.17	9.13	9.06
Average monthly yield of butter fat per cow	33.3	30.5	30.6	29.9	29.8	28.9	29.0	28.1	24.1	19.9
Ratio of monthly milk yields......	111	100	98	95	94	90	90	87	73	59
Ratio of monthly per cents of fat..........	98	100	102	103	104	105	105	106	108	110
Ratio of monthly per cents of solids not fat................................	102	100	101	102	102	102	101	101	100	100
Ratio of monthly fat yields................	109	100	100	98	98	95	95	92	80	65

RECORD OF THIRTEEN SPRING CALVING COWS.

(New York State Station.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow	555	700	675	610	561	525	476	445	394	265
Average monthly per cent of fat.......	4.32	4.16	4.12	4.29	4.34	4.73	4.98	5.18	5.42	5.77
Average monthly per cent of solids not fat................................	9.48	9.41	9.25	9.38	9.45	9.79	9.94	9.89	10.05	10.07
Average monthly yield of butter fat per cow................................	24.0	29.1	27.8	26.2	24.4	24.8	23.8	23.5	23.2	15.5
Ratio of monthly milk yields............	79	100	97	87	80	75	68	64	56	38
Ratio of monthly per cents of fat........	104	100	99	103	104	114	120	124	130	139
Ratio of monthly per cents of solids not fat................................	101	100	98	100	100	104	106	105	107	107
Ratio of monthly fat yields..............	82	100	96	90	84	85	82	81	80	53

RECORD OF TWENTY-FIVE FALL CALVING COWS.

(New York State Station.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow.	664	777	722	700	662	636	592	532	483	357
Average monthly per cent of fat..........	4.64	4.43	4.41	4.50	4.49	4.50	4.39	4.38	4.52	4.63
Average monthly per cent of solids not fat.................	9.51	9.18	9.16	9.27	9.34	9.31	9.42	9.48	9.36	9.69
Average monthly yield of butter fat per cow............................	30.8	34.4	31.8	31.5	29.8	28.7	26.0	23.4	20.9	16.5
Ratio of monthly milk yields.............	85	100	93	90	85	81	76	68	59	46
Ratio of monthly per cents of fat.........	105	100	100	102	101	102	99	99	102	105
Ratio of monthly per cents of solids not fat...........	104	100	100	101	102	102	103	103	102	106
Ratio of monthly fat yields...............	90	100	93	92	87	84	76	68	61	48

RECORD OF SEVEN SPRING CALVING COWS.

(Minnesota Station.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9
Average monthly yield of milk per cow	875	835	692	673	637	547	519	483	455
Average monthly per cent of fat	4.18	4.09	4.44	4.37	4.43	4.58	4.67	4.56	4.83
Average monthly yield of butter fat per cow	36.6	34.2	30.8	29.4	28.4	25.0	24.2	22.0	22.0
Ratio of monthly milk yields	105	100	83	81	77	66	62	58	55
Ratio of monthly per cents of fat	103	100	109	107	109	112	114	111	118
Ratio of monthly fat yields	107	100	90	86	83	73	71	64	64

RECORD OF TEN FALL CALVING COWS.

(Minnesota Station.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9
Average monthly yield of milk per cow	774	775	691	588	599	544	576	598	510
Average monthly per cent of fat	4.49	4.63	4.70	4.62	4.66	4.79	4.80	4.77	4.90
Average monthly yield of butter fat per cow	34.8	35.8	32.5	27.1	27.9	26.2	27.6	28.4	25.0
Ratio of monthly milk yields	100	100	89	76	77	70	74	77	66
Ratio of monthly per cents of fat	97	100	102	100	101	104	104	103	106
Ratio of monthly fat yields	97	100	91	76	78	73	77	79	70

RECORD OF THIRTY-TWO SRPING COWS.

(Vermont, New York, and Minnesota Stations.)

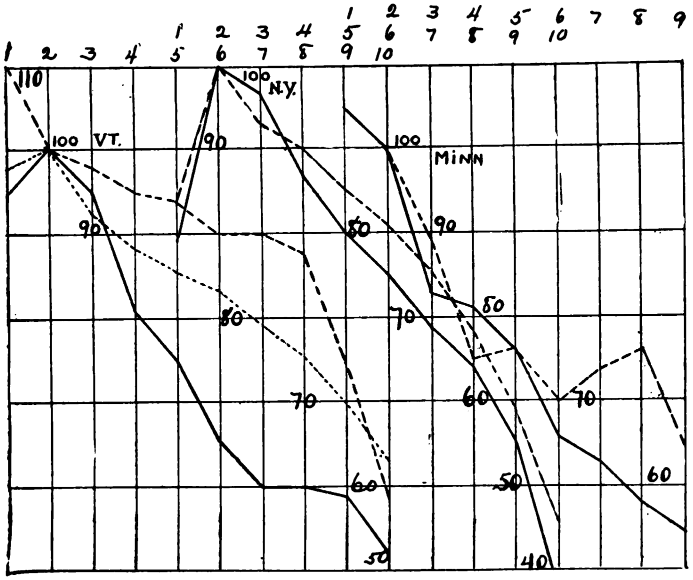
NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow	692	755	700	630	583	522	480	460	430	330
Average monthly per cent of fat	4.41	4.38	4.44	4.52	4.61	4.86	5.11	5.24	5.36	5.76
Average monthly per cent of solids not fat	9.43	9.30	9.17	9.23	9.30	9.55	9.61	9.78	9.78	9.85
Average monthly yield of butter fat per cow	30.5	33.1	31.2	28.5	26.9	25.4	24.5	24.3	23.8	19.1
Ratio of monthly milk yields	92	100	93	83	77	69	64	61	57	44
Ratio of monthly per cents of fat	101	100	102	103	105	111	117	120	122	132
Ratio of monthly per cent of solids not fat	101	100	99	99	100	103	103	105	105	106
Ratio of monthly fat yields	92	100	94	86	81	77	74	74	72	58

RECORD OF SIXTY-TWO FALL COWS.

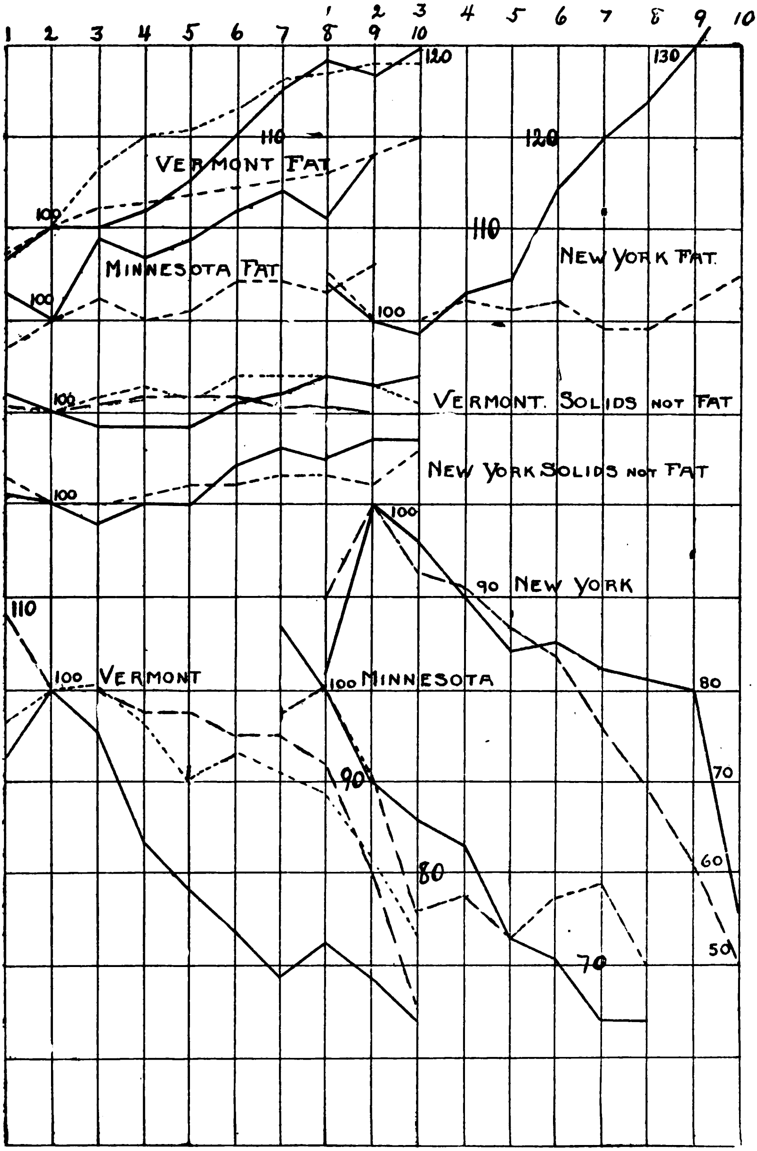
(Vermont, New York, and Minnesota Stations.)

NUMBER OF MONTH.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow.	711	742	684	650	633	605	591	561	479	375
Average monthly per cent of fat.........	4.58	4.55	4.60	4.63	4.66	4.69	4.66	4.67	4.78	4.86
Average monthly per cent of solids not fat....................................	9.38	9.14	9.17	9.27	9.31	9.28	9.32	9.32	9.24	9.36
Average monthly yield of butter fat per cow......................................	32.5	32.9	31.4	30.1	29.5	28.4	27.6	26.3	23.0	18.3
Ratio of monthly milk yields..............	96	100	92	88	85	82	79	75	64	51
Ratio of monthly per cents of fat.........	100	100	101	102	103	103	102	103	105	107
Ratio of monthly per cents of solids not fat....................................	103	100	100	101	102	102	102	102	101	102
Ratio of monthly fat yields................	99	100	95	91	90	86	84	80	70	55

RATIOS OF MONTHLY YIELDS OF MILK (SECOND MONTH YIELD BEING 100), SPRING COWS ——; SUMMER COWS ....; FALL COWS - - - - -.



RATIOS OF MONTHLY PER CENTS OF FAT, OF SOLIDS NOT FAT, AND OF MONTHLY YIELDS OF FAT (SECOND MONTH YIELD BEING 100), SPRING COWS —— ; SUMMER COWS .... ; FALL COWS - - - - -.



2. EXTREME VARIATIONS IN QUALITY DURING THE PERIOD OF LACTATION.

One of the many ways in which the individuality of a cow is strongly shown is in the extent of the changes occurring in quality due to different stages of lactation.

Some cows keep on throughout the milking period with scarce one-half of one per cent. difference in the fat from month to month (composite, not daily, samples), while others vary much more widely, up to two and one-half or even three per cent. Since the publication upon this subject in the Sixth report much more data has been accumulated, and is here presented with a view of studying:

(*a*) Maximum and minimum probable variation in quality during the lactation period.

(*b*) Relation of the time of calving to the extent of quality variation.

(*c*) Relation of breed to the extent of quality variation.

(*d*) Relation of extremes in quality of variation to various portions of the milking period.

The testimony of the same forty-seven Vermont, thirty-eight New York, and seventeen Minnesota cows, will be invoked upon this subject, together with the record of thirteen cows, as printed in our Sixth report, representing a total of one hundred and fifteen lactations. It should be noted that the extremes do not include records made when the cow was giving less than three quarts of milk per day.

(*a*) *Minimum and maximum variations.* The greatest variation in the character of the milk of any one of the one hundred and fifteen cows, in one lactation period, was found to be 3.06 per cent (Jersey), and the least 0 33 per cent (Jersey).

The one hundred and fifteen lactations group as follows:

In 13 cases extremes were 2.00 % or more apart.
In 20 " " " from 1 50 % to 2.00 % apart.
In 39 " " " " 1.00 % to 1.50 % "
In 39 " " " " 0 50 % to 1.00 % "
In 4 " " " less than 0 50 % apart.

The average variation was 1.26 per cent. The average variation in the New York herd was 1.37 per cent, in the Vermont herd 1.20 per cent., in the Minnesota herd 1.20 per cent.

(*b*) *Relation of time of calving to extent of quality variation.* If we separate the cows into groups according to the time of calving, we have another demonstration of the relatively even quality of the milk of fall calving cows.

Using the forty-seven Vermont, thirty-eight New York, and seventeen Minnesota lactations, we find

New York, 13 spring cows, average extremes 1.92 % apart.
Vermont, 12 " " " " 1.50 % "
Minnesota, 7 " " " " 1.29 % "
Vermont. 8 summer " " " 1.25 % "
New York, 25 fall " " " 1 09 % "
Vermont, 26 " " " " 1.04 % "
Minnesota, 10 " " " " 1.14 % "

This showing is a necessary corrollary of that made under the first heading in this article, viz., that fall cows give more even quality of milk than spring cows.

(*c*) ***Relation of breed to extent of quality variation.*** Several breeds of cows are represented in the one hundred and fifteen lactation periods now under consideration. The Vermont cows were Ayrshires, Holsteins, Jerseys, Jersey grades and grades; the New York cows were American Holderness, Ayrshires, Devons, Guernseys, Holsteins, Jerseys and Shorthorns, while there were three Guernseys, two Jerseys, a Shorthorn, and a Polled Angus among the seventeen Minnesota cows. The following summary shows the average variation between lowest and highest tests during the lactation of the average cow of each breed:

BREED.	NUMBER OF LACTATIONS.	VARIATION.
Devon	5	1.73 per cent fat.
Jersey	20	1.47 " "
American Holderness	4	1.40 " "
Guernsey	9	1.39 " "
Grades, mostly high grade Jerseys	38	1.30 " "
Ayrshire	18	1.10 " "
Holstein	7	0.97 " "
Shorthorn	3	0.80 " "

It is well known that cows of certain breeds give richer milk than those of other breeds, thus offering, perhaps, greater possibilities of variation. If, therefore, we arrange the breeds in accordance with the proportion of the average variation to the fat per cent., we find the breeds arranged in a different order.

BREED.	NUMBER OF LACTATIONS.	VARIATION EXPRESSED IN PERCENTAGE OF 100.
American Holderness	4	38
Devon	5	37
Ayrshire	18	30
Grades	38	28
Holstein	7	28
Jersey	20	27
Guernsey	9	27
Shorthorn	3	18

For example, the average American Holderness milk contained 4.55 per cent. of fat, and 1.73 per cent., the variation observed, is 38 per cent. thereof.

The upper table shows quite wide differences, but where the variations are compared with the average fat percentages, the differences appear less.

The Ayrshires, Jersey grades, Holsteins, Jerseys and Guernseys, bunch together, with extreme variations ranging from 30 to 27 per cent. of their respective average fat per cents. The Holderness and Devon cows seem to vary more widely in their milk quality during the lactation period, and the Shorthorns, if we may judge from three lactations, less widely than the others.

(*d*) *Relation of extremes to various portions of the milking period.* In the opening sentence, under section one of this article, it is said that "It is well known that cows usually give their thinnest milk in the early stages of lactation." This is found to be generally true in reviewing the data obtained from the Vermont and Minnesota herds, but not so much so in the case of the New York herd.

The condensation of records is as follows:

THE RELATION BETWEEN THE QUALITY OF MILK AND THE MONTH OF LACTATION.

STATE	SEASON OF CALVING.	Number of Cows.	NUMBER OF MONTH.														
			First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	Tenth	Eleventh	Twelfth	Thirteenth	Fourteenth	Fifteenth
LOWEST TEST.																	
Vermont	Spring	12	6	1	3	1	..	1	..	..	..	..	..	..	..	..	..
	Summer	8	5	1	1	..	..	..	..	..	..	..	..	1	..	..	..
	Fall	26	10	5	1	2	1	2	..	2	1	2	..	..	..	..	..
New York	Spring	13	4	2	4	2	1	..	..	..	..	..	..	..	..	..	.
	Fall	25	5	1	4	2	2	..	4	2	3	2	..	..	..	..	..
Minnesota	Spring	7	2	4	..	1	..	..	..	..	..	..	..	..	..	..	..
	Fall	10	7	..	1	1	1	..	..	..	..	..	..	..	..	..	..
	Totals	101	39	14	14	9	5	3	4	4	4	4	..	1	..	.	..
HIGHEST TEST.																	
Vermont	Spring	12	..	..	..	..	..	..	..	..	1	2	3	2	1	2	1
	Summer	8	..	..	..	..	..	..	..	4	1	..	2	..	..	..	1
	Fall	26	..	..	1	1	..	..	1	2	4	5	4	3	2	2	1
New York	Spring	13	..	..	..	..	..	..	2	..	6	5	..	..	..	..	..
	Fall	25	10	1	1	1	3	3	2	..	1	3	..	..	..	..	.
Minnesota	Spring	7	..	..	..	..	..	..	1	..	1	..	4	..	1	..	..
	Fall	10	..	..	..	..	..	..	1	1	1	2	2	1	2	..	..
	Totals	101	10	1	2	2	3	3	7	7	15	17	15	6	6	4	3

The following illustration may serve to make the table more clear. Of twelve Vermont spring calving cows, six gave thinnest milk during the first month of lactation, three during the third month, and one each during the second, fourth and fifth months.

The records show clearly, as has been already otherwise shown, that the thinnest milk is given early in lactation; also, that as a rule the milk of the first month is somewhat thinner than that of succeeding months. Over three-fourths of the Vermont herd, and sixteen out of seventeen of the Minnesota herd, gave the thinnest milk during some one of the first four months of lactation. Two-thirds of the total number of these two herds gave thinnest milk in the first two months, and almost half in the first month. The New York herd scattered more, yet two-thirds gave thinnest milk within the first four months.

The time when the richest milk is given is not so clearly defined. Ninety-three per cent. of the Vermont herd and eighty-eight per cent. of the Minnesota herd gave richest milk after the seventh month of lactation, while sixty per cent. of the New York herd gave richest milk before the eighth month began, and over a quarter of the entire herd gave the richest milk the very first month of lactation. The New York spring cows resemble the Vermont and Minnesota herds in this respect, but the records of the New York fall cows are precisely reverse to the others, seven-eighths of them giving richest milk before the eighth month.

A partial explanation is to be found in the arbitrary limitation of the New York records to a ten months' lactation period. The New York cows were soiled throughout the year, while those belonging to the other herds were pastured.

What variation in the pounds of milk to make a pound of butter might be expected in the case of the widest variations found in the hundred odd lactations included in this study? There were fourteen cases in which extremes varied two per cent. or more in fat. These, together with the pounds of milk necessary to make a pound of †butter, are collated in the following table:

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†Using the one-sixth conversion factor recommended and adopted by the Denver Convention of the Association of American Agricultural Colleges and Experiment Stations.

COW.	SOURCE OF DATA.	PER CENT FAT.			POUNDS MILK TO MAKE ONE POUND BUTTER.		
		LOWEST	HIGHEST	DIFFERENCE	LOWEST	HIGHEST	DIFFERENCE
		%	%	%	lbs.	lbs.	lbs.
Bright Eyes........	6th Rpt. Vt. Expt. Stat.	4.79	7.27	2.48	17.9	11.8	6.1
Dorothy.............	" " " "	3.71	6.32	2.61	23.1	13.6	9.5
Pipchin...............	" " " "	3 00	5.03	2.03	28.6	17.0	11.6
Genevieve's Gift ..	12th Rpt. N. Y. Expt. Stat.....	3.25	6.15	2.90	26.4	14.0	12.4
Albert's Carol	" " " "	3.99	7.05	3.06	21.5	12.2	9.3
Barbara Allen.....	" " " "	4.23	6.66	2.43	20.3	12.9	7.4
" "	" " " "	4.15	6.45	2.30	20.7	13.4	7.3
Oriole.	" " " "	4.36	6.87	2.51	19.6	12.5	7.1
Fairie...............	Vt. Expt. Stat................	4.44	6.93	2.49	19.2	12.4	6.8
Flora................	" " "	4.21	6.25	2.04	20.4	13.8	6.6
Clover.	" " "	4.51	6.74	2.23	19.0	12.7	6.3
Golden Rod........	" " "	5.48	8.20	2.72	15.6	10.4	5.2
Dora................	Bul. 35, Minn. Expt. Stat....	4.77	6.97	2.20	18.0	12.3	5.7
Dolly Athol........	Bul 22, Vt. Expt. Stat..	4.41	6.84	2.43	19.4	12.5	6.9

They are the widest, moreover, of over a hundred cases. The cows represented are of several breeds, old and young, well fed, but frequently submitted to radical changes in feeding. Yet the widest change in pounds of milk to make a pound of butter is from 26.4 to 14 pounds.

The not infrequent report, and, indeed, record of extraordinary fluctuations in the pounds of milk required to make a pound of butter from the same cow at different times in the same lactation, the lack of accompanying milk analyses, and the public credulity upon the subject, were commented upon in this connection in our Sixth report. The more the milk itself is studied the less likely it seems that such large variations can occur, as a lowering of from 18 to 20 pounds of milk to a pound of butter to 12, 10 or even 8 pounds of milk per pound of butter, followed by a subsequent rise to the original amount. The study of these many lactations does not add to our confidence in the correctness of this class of records. The extraordinary change of 20 pounds to 10 pounds of milk to a pound of butter, the milk flow being proportionately maintained at the same time, is possible but highly improbable.

3. VARIATIONS IN QUALITY AND QUANTITY OF MILK FROM YEAR TO YEAR.

Does a cow give on the average year after year an even quality of milk? Does a cow as she grows older give poorer or better milk than when she is a heifer with the first calf? Can an accurate judgment of the worth of a cow be made during her first lactation?

Data upon these points was printed in the Sixth and Seventh reports of this station, and further figures taken from our own and the New York data are here printed, more as a matter of record and to accumulate evidence than with the idea that anything new will be brought to light. In each case the average per cent. of fat given represents not a single analysis, but the result of the calculation of from two dozen or more analyses of composite samples, in the case of the Vermont herd, and of (to us) unknown but large numbers of analyses in the case of the New York herd. The first lactation given is not of necessity the first lactation of the cow, but the first of which record exists. In some cases, however, the cows were heifers.

VERMONT STATION HERD.

COW.	LACTATION NUMBER.			EXTREME.
	1	2	3	
Sadie's Delight	4.68	4.65	..	0.03
Bright Eyes	5.66	5.75	....	0.09
Pipchin 2nd	3.40	3.50	...	0.10
La Violette	5.41	5.39	....	0.02
Marburi	4.87	4.86	....	0.01
Cloverette	3.37	3.53	....	0.16
Beauty	5.37	5.78	....	0.41
Mercedes	3.69	3.72	...	0.03
Minerva	5.12	5.06	5.15	0.09
Dorothy	4.73	....	5.02	0.29
Rena Myrtle	3.57	3.78	3.78	0.21
Lolita	3.90	....	3.98	0.08
Gretchen	4.56	5.08	4.83	0.52
Bess	5.07	5.23	....	0.16
Bettie	5.06	4.66	....	0.40
Brownie	5.59	5.41	....	0.18
Clover	5.69	5.98	....	0.29
Dandelion	5.57	5.58	....	0.01
Dora	5.35	5.95	....	0.60
Fairy	5.09	5.27	....	0.18
Fanny	4.80	5.28	....	0.48
Flora	5.10	5.34	....	0.24
Golden Rod	6.25	6.39	....	0.14
Jeannie	5.04	5.06	....	0.02
Jessie	5.66	5.82	....	0.16
Julia	5.38	5.68	....	0.30
Maizie	4.51	4.94	....	0.43
Red Top	4.63	4.64	...	0.01
Rowena	4.72	4.48	...	0.24

NEW YORK STATION HERD.

COW.	LACTATION NUMBER.				EXTREME.
	1	2	3	4	
Maggie 6th	3.49	3.72	3.92	...	0.43
Junietta Peerless	....	3.20	3.43	....	0.23
Manton Belle	3.36	3.67	3.59	3.45	0.31
Miss Flow 5th	4.24	3.44	3.56	3.88	0.80
Queen Dutchess	3.87	3.66	....	...	0.21
Genevieve's Gift	4.75	5.23	...	....	0.48
Ione	4.30	4.50	....	....	0.20
Oriole	5.02	5.42	....	....	0.40
Rosette Ford	4.97	5.73	....	....	0.76
Albert's Carol	5.17	5.85	....	....	0.68
Barbara Allen	5.31	4.96	5.41	....	0.46
Countess Flavia	5.75	5.82	6.09	6.09	0.34
Gilderbloom	5.65	....	5.45	....	0.20
Betsey 10th	4.28	4.56	....	....	0.28

NOTE.—The figures given for the Vermont cows are not exactly those of a single lactation, beginning at calving and ending at drying off, but are records for a year. In the majority of cases, these are essentially lactations, and the recalculation of several taken at random for exact lactation periods, so slightly altered the figures that they are allowed to stand with this remark. The New York figures are all the average of the first ten months' milk.

The first eight cases are reprinted from the Seventh report of this station. But six of the forty-three cows represented (one-seventh of the entire number) make a change of ten per cent. in the quality of their milk in successive years. When we consider the many different breeds and the very variable feeding represented in this tabulation, it becomes strong evidence of the evenness usually existing in the quality of milk throughout the normal healthy life of the cow. It will be interesting to note whether what little difference exists is in the direction of improvement or deterioration.

Better milk was given twenty-eight times, poorer, seven times, and the same quality, eight times in forty-three. In other words, two-thirds of the cows bettered their milk slightly as they grew older. The change, however, is not sufficient to lay great stress upon, being less than six per cent. of the entire amount of fat present. It would appear safe, then, to repeat and emphasize with slight modification the conclusion hitherto drawn, that the same general character of the milk will be maintained through healthy life, with no general tendency to becoming materially richer, and certainly never to becoming poorer.

The variations in quantity of milk from year to year are directly dependent upon the kind and amount of food and upon the environment of the cow, conditions which in experimental herds are bound to be variable. It is therefore not surprising to find much greater fluctuations in milk and butter yield than in the quality of the milk.

The extremes of variation are as follows (lowest amount = 100):

	QUANTITY OF MILK.		QUANTITY OF BUTTER.	
	Maximum.	Minimum.	Maximum.	Minimum.
*Vermont	143	102	142	103
New York	141	101	150	102

The variations in butter yields were fully as pronounced as those in milk yield.

4. THE QUALITY OF THE MILK OF STRIPPERS.

It is well known that stripper milk is usually richer than that given when the cow is in full flush, and that in particular the milk of the last few days or weeks is extra rich. A case of lowered quality at the time of drying off, which was considered an abnormal milk, is noted in the Sixth report of this station (page 128). A still more pronounced case of the same nature having been recently observed, the records of the station herd from 1892 to 1896 have been carefully reviewed for testimony on the relation between the quality of stripper milk and the length of time before the next calving. Attention should again be called to the fact that our system of daily weights and bi-monthly (or yet more frequent) composite samples of each cow's milk gives us a close idea of all changes in quantity and quality going on in the milk.

It was found that *without exception* the milk given during the last few weeks before going dry was richer in fat and solids not fat, and of a higher specific gravity, than the average of the milking period, *provided the cow*

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* Excluding four cows which aborted.

had been pregnant for two months or more. This rule did not hold good, however, when farrow cows or those which had but recently been served went dry. We have the records of seven such cases, which are tabulated below. Dorothy was one month with calf, Lolita (first record) just served, and Lillian Douglas possibly a month in calf, but probably farrow. All others were farrow.

Cow.	Breed.	AVERAGE.				Pounds of Milk Daily.	STRIPPING.			
		PER CENT. OF					PER CENT. OF.			
		Total Solids.	Fat.	Solids Not Fat.	Lactometer Reading.		Total Solids.	Fat.	Solids Not Fat.	Lactometer Reading.
Myrtle......	Grade Jersey...	15.94	5.94	10.00	35.2	7	15.97	5.95	10.02	35.2
Rena Myrtle.....	Ayrshire.......	12.49	3.81	8.68	31.7	3	13.04	4.32	8.72	31.3
Waxy..............	Grade Jersey,..	13 93	4.74	9.19	33.0	6	14.51	5.60	8.91	31.2
Dorothy..........	" " ...	13.91	4.73	9.18	32.9	4	14.42	5.32	9.10	32.1
Lolita..........	Ayrshire........	12.68	3.90	8.78	32.0	5½	10.03	2.98	7.35	27.0
"	"	12.83	4.00	8.83	32.1	5	10.94	3.22	7 72	28.5
Lillian Douglas..	"	......	3.75	......	......	6	9.47	2.58	6.89	25.5

A study of the table shows that Myrtle gave exactly average quality when drying, and that the next three cows gave milk much richer in fat but no better or even somewhat poorer in solids not fat, and of a lower gravity. Two registered Ayrshire cows, Lolita and Lillian Douglas, appeared a law unto themselves and gave poorer milk at drying off than at any other time, both fat and solids not fat shrinking.

In this connection it should be noted that the first cow, Lolita, dried off in orthodox fashion in 1892, gave during the last month of her lactation milk with the following average analysis: Total solids, 13.43 per cent; fat, 4.54 per cent,; solids not fat, 8.89 per cent.; lactometer reading, 31.9. She came in, however, in less than two months.

The milk of Lillian Douglas was periodically analyzed for some two months, and each succeeding sample showed the same abnormal character. During the last two days of her lactation she gave two pounds of milk with the following amazing composition: *Total solids*, 7.05 *per cent.; fat*, 1.10 *per cent.; solids not fat*, 5.97 *per cent.; lactometer reading*, 23. She was in fine condition, eating heartily, but not grained.

The fact that both of these cows are Ayrshires is suggestive, yet is probably simply a coincidence. Other Ayrshires belonging to the station herd, due to calve within a reasonable time after going dry, have shown no such tendencies. The data, therefore, is not sufficiently large to enable us to generalize. These two milks, unquestionably genuine and unadulterated, are far below all state standards, and touch, it is thought, the lowest limits of solids not fat and specific gravity in genuine milk hitherto reported. Fortunately such milks occur but seldom.

The records now under discussion indicate quite strongly that the hypothesis advanced in our Sixth report regarding the causes of the increase in the richness of milk as the cow progresses in lactation is true, viz.: "There are two factors that work to influence the richness of the milk—a shrinkage in quantity of milk has a slight tendency to increase its richness—the mere being in calf has a strong tendency to make the milk richer, and is the cause of most of the increased richness that is found in the milk of cows as they dry up preparatory to calving."

5. WHEN TO TEST A COW FOR QUALITY AND QUANTITY OF MILK.

Quality.—The Sixth report stated as a result of the study of the milking habits of seventeen cows, that "the mean of a test of two composite samples taken at six weeks and six months after calving agrees almost exactly with the average character of the milk for the entire milking period," and that "by adding one-eighth of a per cent. to the quality of milk the cow is giving during the fourth month after calving, a very close approximation to the average quality of the milk for the whole milking period" would be obtained.

The following table shows the results of the comparison of many hundred analyses of the milk of forty-six cows. It gives the analyses obtained by averaging the quality of the milk given every two weeks, from the fourth to the tenth week after calving, with that given every two weeks from the middle of the fifth to the middle of the seventh month after calving. The cows are divided into groups according to the time of calving. Calculation was also made using the milk of the fifth and eighth months after calving, but are not printed as they were respectively low and high of truth:

Weeks after calving.	Months after calving.	TWELVE SPRING COWS, AVERAGE FOR YEAR 5.13 % FAT.					EIGHT SUMMER COWS, AVERAGE FOR YEAR 5.13 % FAT.					TWENTY-SIX FALL COWS, AVERAGE FOR YEAR 4.85 % FAT.				
		Fat.	Difference.	Extremes of difference from average.		Per cent. of total number within 0.20 per cent. of average.	Fat.	Difference.	Extremes of difference from average.		Per cent. of total number within 0.20 per cent. of average.	Fat.	Difference.	Extremes of difference from average.		Per cent. of total number within 0.20 per cent. of average.
		%	%	%	%		%	%	%	%		%	%	%	%	
4	5½	4.97	0.32	+.61	—.58	25	4.94	0.24	+.07	—.67	63	4.74	0.19	+.37	—.60	54
6		5.07	0.17	+.54	—.33	58	4.92	0.29	+.20	—.64	63	4.75	0.16	+.23	—.43	66
8		4.99	0.20	+.42	—.47	50	5.05	0,13	+.14	—.37	75	4.78	0.13	+.22	—.45	81
10		5.09	0.21	+.52	—.44	58	5.19	0.21	+.50	— .21	63	4.83	0.15	+.33	—.35	66
4	6	4.97	0.20	+.12	—.69	50	4.95	0.21	+.57	—.39	50	4.75	0.19	+.42	—.66	62
6		5.07	0.14	+.30	—.33	58	5.04	0.31	+.60	—.60	37	4.76	0.17	+.25	— 58	62
8		5.07	0.19	+.31	—.39	42	5.18	0.12	+.37	—.14	75	4.79	0.13	+.43	—.32	78
10		5.09	0.18	+.40	—.43	50	5.32	0.29	+.56	—.31	37	4.84	0.15	+.45	—.23	78
4	6½	5.07	0.19	+.40	—.46	58	5.00	0.19	+.18	—.32	50	4.74	0.20	+.39	—.57	62
6		5.17	0.14	+.40	—.17	75	5.00	0.19	+.21	—.47	50	4.75	0.17	+.19	—.58	70
8		5.19	0.16	+.50	—.25	67	5.13	0.07	+.13	—.16	100	4.79	0.13	+.34	—.32	78
10		5.20	0.16	+.65	—.23	67	5.27	0.20	+.55	—.36	37	4.83	0.14	+.41	—.23	70
4	7	5.07	0.24	+.32	—.72	50	5.06	0.13	+.11	—.34	75	4.74	0.21	+.57	—.55	46
6		5.17	0 17	+.30	—.35	58	5.04	0.17	+.26	—.47	63	4.75	0.18	+.30	—.45	62
8		5.17	0.16	+.41	—.42	58	5.18	0.09	+.21	—.17	87	4.78	0.14	+.32	—.33	74
10		5.19	0.16	+.56	—.23	75	5.32	0.26	+.63	—.38	63	4.83	0.13	+.42	—.37	74
4	7½	5.07	0.24	+.40	—.69	42	5.10	0.16	+.20	—.31	75	4.77	0.21	+.57	—.48	58
6		5.16	0.16	+.35	—.20	75	5.08	0.20	+.54	—.56	63	4.77	0.16	+.30	—.46	66
8		5.17	0.19	+.50	—.25	50	5.22	0.18	+.32	—.27	63	4.80	0.16	+.33	—.35	54
10		5.19	0.23	+.65	—.49	50	5.36	0.35	+.61	—.42	25	4.86	0.16	+.42	— .38	66

It will be noted that there are usually some wide variations from the mean result, yet these means are in many cases close to the true yearly average as given at the head of the table; also that in several cases, three-fourths or upwards of the results are within 0.20 per cent. of the true yearly average.

In order to make the above table more clear the following explanation of the first line under spring cows is offered: Twelve spring cows gave milk averaging for the year 5.13 per cent. fat. The arithmetical average of the per cents of fat given in the milk of these twelve cows when four weeks from calving, with those given when five and one-half months along in milk, was 4.97 per cent fat. There were variations from the true yearly average, some being plus, and some minus; the total average difference (regardless whether results were plus or minus) was 0.32 per cent. The maximum excess was 0.61 per cent. (5.13 + 0.61 = 5.74 per cent), the minimum deficiency, 0.58 per cent. (5.13 — 0.58 = 4.55 per cent). The results of this calculation showed that twenty-five per cent of the cows (three in this case) gave milk within 0.20 per cent. (4.93 to 5.33 per cent.) of the true yearly average, i. e. 5.13 per cent. fat.

A study of the table shows the essential correctness of the first statement quoted from the former report, qualifying, perhaps, the phrase "almost exactly." It also shows that many other combinations of tests made early and late in lactation may be used and quite as reliable results be obtained.

One is about as likely to secure trustworthy figures by analyzing the milk taken at six, eight or ten weeks after calving, and again at any time when the cow is five and a half to seven and a half months along in milk, as by sticking religiously to the six and six rule.

In the records now under discussion the results seem to have been nearest to true yearly average when the samples were taken, as follows:

	FIRST SAMPLES TAKEN.	SECOND SAMPLES TAKEN.
Spring cows..	6 weeks.	6½ to 7½ months from calving.
Summer cows	8 weeks.	6 to 7 " " "
Fall cows.....	8 or 10 weeks.	5½ to 7 " " "

It is far too often the case, however, that the Babcock tester rests and rusts after its purchase. There is a certain amount of inertia on the part of the operator to be overcome each time it is used. If, therefore, trustworthy results may be obtained, making two tests within a comparatively short time, there is perhaps greater liability of their being promptly and properly done than if some months intervene between analyses.

A series of comparisons were made of the quality of the milk given by the same forty-six Vermont cows which contributed to the last table each month from the third to the eighth, with the true yearly average. Each month's milk was twice sampled for four days, at intervals two weeks apart, and the figures reported are the mean of the two analyses.

The table upon page 179 shows the results of the comparisons together with similar ones obtained from the New York and Minnesota records already referred to.

A study of the table in question shows that the spring calving cows of the Vermont and New York herds gave more nearly average milk at the sixth month than at the fourth, the month recommended for sampling in our Sixth report. The fat per cents are nearer average, "differences" less, and a larger proportion of the total number of records is within 0.20 per cent. of truth at the sixth month than at any other time. The milk of the Minnesota herd ran very uniformly, and no choice can be made from the data at hand. Analyses at six months would tend to run somewhat high of truth. The subtraction of one-sixth of one per cent. would tend to give closer results.

The summer calving cows gave nearly average milk in the third, fourth, and fifth months, and apparently might have been safely tested at any time during this period.

The fall calving cows of all three herds, making a more even quality of milk than the others and increasing but slowly in fat percentage, gave essentially average milk during six months (third to eighth).

MONTHS OF LACTATION.	VERMONT HERD.					NEW YORK HERD.					MINNESOTA HERD.				
	Fat.	Difference.	Extremes of difference from average.		Per cent. of total number within 0.20 % of average.	Fat.	Difference.	Extremes of difference from average.		Per cent. of total number within 0.20 % of average.	Fat.	Difference.	Extremes of difference from average.		Per cent. of total number within 0.20 % of average.
	%	%	%	%		%	%	%	%		%	%	%	%	
	12 Spring Cows, average 5.13 % fat.					13 Spring Cows, average 4.59 % fat.					7 Spring Cows, average 4.42 % fat.				
III	4.79	0.35	− .11	−.89	8	4.12	0.48	+ .04	−.89	23	4.44	0.24	+.21	−.34	29
IV	4.86	0.36	+ .57	−.66	17	4.29	0.30	− .02	−.53	31	4.37	0.28	+.25	−.62	57
V	5.01	0.26	+ .42	−.48	25	4.34	0.35	+ .30	−.57	23	4.43	0.29	+.29	−.75	43
VI	5.25	0.22	+ .62	−.38	58	4.73	0.26	+ .83	−.16	53	4.58	0.24	+.52	−.45	43
VII	5.50	0.27	+ .99	+.02	50	4.98	0.42	+1.04	−.14	31	4.67	0.35	+.75	−.50	29
VIII	5.71	0.57	+1.28	+.04	17	5.18	0.57	+1.45	+.14	15	4.56	0.25	+.27	−.54	67
	8 Summer Cows, average 5.18 % fat.														
III	5.05	0.17	+ .13	−.39	75										
IV	5.17	0.15	+ .28	−.22	75										
V	5.24	0.12	+ .27	−.06	75										
VI	5.30	0.22	+ .51	−.24	50										
VII	5.38	0.28	+ .78	−.10	63										
VIII	5.50	0.41	+1.05	−.20	25										
	26 Fall Cows, average 4.85 % fat.					25 Fall Cows, average 4.46 % fat.					10 Fall Cows, average 4.68 % fat.				
III	4.76	0.18	+ .50	−.82	81	4.41	0.24	+ .45	−.61	56	4.70	0.20	+.19	−.54	70
IV	4.79	0.20	+ .57	−.41	50	4.50	0.21	+ .53	−.66	56	4.62	0.24	+.10	−.54	50
V	4.86	0.12	+ .35	−.31	89	4.49	0.25	+ .77	−.58	48	4.66	0.19	+.06	−.60	80
VI	4.88	0.15	+ .44	−.34	77	4.50	0.21	+ .50	−.55	64	4.79	0.11	+.17	−.35	90
VII	4.91	0.17	+ .53	−.34	69	4.39	0.24	+ .63	−.94	52	4.80	0.17	+.36	−.25	70
VIII	4.95	0.19	+ .71	−.44	59	4.38	0.20	+ .38	−.77	68	4.77	0.24	+.57	−.35	30

On the whole the closest results seem to have been obtained as follows:

Vermont herd, fifth and sixth months.

New York herd, sixth and eighth months (but less clearly).

Minnesota herd, fifth, sixth, and seventh months.

It would appear that quite a wide latitude of choice may be allowed in the selection of the date for testing fall calving cows. It should always be borne in mind, however, that the samples should be properly taken. The test of a single sample, drawn from a single milking or day, will not of necessity or, indeed, usually, give trustworthy results.

Those who have hitherto followed the advice of this station and sampled on the fourth month from calving, or at six weeks and six months after calving, need not fear that the results presented herewith throw doubt upon the essential correctness of their work. They simply serve to indicate that probably other times in the lactation period may be chosen for sampling with at least equal certainty of accurate results, and that these other choices are perhaps a little more likely to give average results.

It has been many times said, and cannot be too often repeated, that, thanks to the Babcock test, no dairyman now has excuse for not knowing the quality of the milk of each of his cows. And if, as these results seem to indicate, trustworthy results can be obtained using but two samples yearly per cow, the testing of a herd becomes a very small thing so far as time and expense are concerned, but frequently a very great thing in the results it brings forth. Too great stress, however, cannot be laid upon the necessity of properly taking and properly analyzing the samples.

A former dairyman of this station left us in order to accept a similar position upon the farm of Mr. W. K. Vanderbilt, of New York. He writes: "The Babcock test has killed ten of our cows. Mr. Vanderbilt cannot afford to keep cows that do not pay their way." Can you?

Quantity. A means of measuring the quantity of milk is quite as important as one for determining its quality. This is a simple operation; it needs no expensive apparatus, nor does it require the least degree of skill. A spring balance, paper and pencil, complete the outfit.

The weighing of the milk of each cow in the herd for each milking is not as formidable a task as many are prone to think. If the outfit is properly arranged and located, the delay caused thereby need not exceed five minutes to a milking for a herd of thirty cows, and it is confidently asserted that the information obtained from such a set of records would be well worth the time and trouble expended.

For such, however, as feel that this small amount of time and labor is too great a burden, we would suggest periodical weights as being for most purposes quite satisfactory. The more frequent the weighings, the more accurate will be the results. Farrington* found that if the milk was weighed and tested once in seven, ten, fifteen, or thirty days, and the total milk flow and the butter yield was calculated therefrom, results were obtained which varied as follows from the correct results, *i. e.*, those found by daily weights:

MILK YIELD (CALLING CORRECT YIELD 100).

Weighing milk once in	7 days.	10 days.	15 days.	30 days.
Highest percentage	99.5	101.0	101.0	102.0
Lowest percentage	96.1	94.4	93.4	90.3
Difference	3.4	6.6	7.6	11.2
Average of six cows	98.0	98.0	97.6	96.4

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*Ill. Agr. Expt. Station, Bul. 24, p. 161.

BUTTER YIELD (CALLING CORRECT YIELD 100).

Weighing and testing milk once in	7 days.	10 days.	15 days.	30 days.
Highest percentage	102.6	104.0	101.4	104.0
Lowest percentage	94.8	94.8	95.4	89.6
Difference	7.8	9.2	6.0	15.4
Average of six cows	98.0	99.4	98.5	97.0

A similar series of calculations have been made in connection with several of the Vermont station cows, based on the milk yield of four days in the middle of each month.

The following table shows the actual and the calculated milk yields, the true yearly average per cent. of fat, the fat per cent. calcuated from two analyses, either two weeks or some months apart, and the butter yields obtained by using the three fat percentages:

COMPARATIVE ACCURACY OF ACTUAL AND CALCULATED YIELDS.

SEVEN SPRING CALVING COWS.	POUNDS OF MILK.			PER CENT. OF FAT.			POUNDS OF BUTTER.				
	Actual.	Calculated.	Calculated ± actual.	True yearly average.	6 months' lactation.	6 weeks and 7 months in lactation.	Actual.	Calculated, using 6 months' tests.	Calculated, using 6 weeks' and 7 months' tests.	Calculated ± actual.	Calculated ± actual.
Bettie	5052	5165	+113	4 76	4.99	5.20	280.6	300 4	313.3	+20	+33
Fairie	5585	5678	+ 93	5.19	5.24	5.31	333.2	347.1	351.7	+14	+19
Goldie	5443	5585	+142	5.60	5.50	5.79	355.8	358.4	377.3	+ 3	+23
Julia	5341	5481	+140	5.57	5.72	6 10	347.1	365.8	390 0	+19	+43
Maizie	6384	6449	+ 65	4-76	4.35	4 80	354.6	327 4	361.2	- 7	+ 7
Red Top	4960	4877	— 83	4 90	4.45	4.72	283.6	253.2	268.6	—30	—25
Rowena	4022	4176	+154	4.49	4.85	4.89	210.8	236.3	238.2	+25	+27
Average	5255	5293	113	5.04	5 01	5 26	309.4	312.7	328.6	20	26

COMPARATIVE ACCURACY OF ACTUAL AND CALCULATED YIELDS.

NINETEEN FALL CALVING COWS.	POUNDS OF MILK.			PER CENT. OF FAT.			POUNDS OF BUTTER.				
	Actual.	Calculated.	Calculated ± actual.	True yearly average.	6 months' lactation.	8 weeks and 6 months in lactation.	Actual.	Calculated, using 6 months' test.	Calculated, using 8 weeks' and 6 months' test.	Calculated ± actual.	Calculated ± actual.
Acme	8092	8179	+ 87	4.05	4 15	4.01	382.5	396.0	382.6	+14	0
Atalanta	6639	7075	+436	3.85	3.96	3.70	297.9	326.9	305.4	+29	+ 8
Bess	7717	7805	+ 88	5.13	5.35	5.27	462.2	487 2	479.9	+25	+17
Brownie	4886	4904	+ 18	5.81	5.92	5.93	331.3	338 7	339.3	+ 7	+ 7
Dandelion	4522	4446	— 76	5.70	5.55	5.82	300.7	287 9	301.9	—13	+ 1
Dora	5693	5874	+181	5.56	5.46	5.39	369 3	374 2	369.4	+ 5	0
Eulalie	6412	6551	+139	4.96	4 90	5.14	370.9	374.5	392.8	+ 4	+22
Golden Rod	5327	5426	+ 99	6.67	6.45	7.14	414.5	408 3	452.0	— 6	+38
Jeannie	3083	3102	+ 19	5.23	5.05	5.10	187.4	182.7	184 6	— 5	— 2
Jersey Lily	5125	4906	—219	5.72	5.69	5.63	342.0	325.7	322.2	—17	—20
Jessie	6890	6914	+ 24	5 70	5.70	5.99	457.7	459.8	483.2	+ 2	+26
Kinkora	4871	4995	+124	5.14	5.03	5.45	291.7	293.1	317.6	+ 2	+26
Lady Le Brocq	5829	6000	+171	5.64	5.61	5.70	383.8	392.7	399.0	+ 9	+15
Nancy B.,	7831	8136	+305	3.90	3.88	3.93	356.4	368.3	373 0	+12	+17
Nett	8437	7964	—473	3.99	4.07	3.90	393 2	378.2	362.4	—15	—31
Portelette	6440	6513	+ 73	4.55	4.28	4.18	341.6	325.2	317.6	—16	—24
Regina	5372	5290	— 82	4 27	4 13	4.18	267.9	254.9	258 0	—13	—11
Rhoda	5015	5292	+277	4.87	5.00	5.15	284.8	308 7	318.0	+14	+34
Waxy	4892	4915	+ 23	4.74	4.83	4.50	270.8	277.0	258.1	+ 7	—12
Average	5951	6015	153	5 02	5.00	5.05	342.4	345.2	348 2	11	14

Reducing the salient points of these tables to the scale of 100, (the actual yields of milk and butter being called 100, as a standard), we find:

	SEVEN SPRING COWS.	NINETEEN FALL COWS.
Milk yield; highest percentage	103.8	106.6
" lowest "	98.3	94.4
Difference	5.5	12.2
Average	100.7	101.1
*Butter yield; highest percentage	112.1	109.7
" lowest "	89.3	95.2
Difference	22.8	14.5
Average	101.1	100.8
†Butter yield; highest percentage	112.4	112.0
" lowest "	94.8	92.2
Difference	17.6	19.8
Average	106.2	101.7

*Tests two weeks apart. Tests at wide intervals.

The results of milk yield calculation are fairly satisfactory. With seven spring cows the extremes were within four per cent. of truth, and with nineteen fall cows, within seven per cent. of truth. The average results are rather poorer than those obtained by Farrington with six cows, weighing once in seven days, rather better than when the milk was weighed once in ten days, and decidedly better than when weights were less frequently made. Extremes, of course, widen with an increase in the number of animals used.

The calculated butter yields naturally agree less closely with truth than in the Illinois experiments, since our results are based upon but two analyses, while theirs for the 7, 10, 15 and 30 day weights are based upon 52, 36, 24, and 12 analyses respectively. Extremes, however, are 12½ per cent. above and 12 per cent. below the truth. The calculated milk yields of 43 per cent. of the spring cows, and 53 per cent. of the fall cows, were within two per cent. of truth, while of the calculated butter yields of the spring and fall cows, respectively, 43 and 90 per cents by the first method, and 14 and 58 per cents by the second method, were within five per cent. of truth.

It is thought that there is greater likelihood that weights would be made for four consecutive days than for four, three, or two separate days in a month. The results of such weights properly calculated, linked with the results of the Babcock test, properly handled, on composite samples properly taken at the proper time, would be of great service to the dairyman, enabling him, with a minimum of time, labor and expense, to attain, if not a maximum of accuracy, at least a close approximation thereto.

At the risk of repetition, our conception of "proper" calculation, handling, sampling, etc., may be briefly summarized as follows:

Milk may be weighed for four days in the middle of the month, and the entire month's yield obtained with considerable accuracy (barring sickness and drying off) by multiplying the total by 7, 7½ or 7¾, according to the month. It is most readily done by the use of hanging spring balances, the hand of which is set back so that the empty pail brings it to zero.

The proper handling of the Babcock test involves careful attention to details which cannot be given here, but which are printed in bulletins 24 and 31 of the Wisconsin experiment station, Madison, Wis., in the bulletins of several other stations, in a special bulletin of this station, in the report of the 26th annual meeting of the Vermont Dairymen's Association, and by many makers of Babcock apparatus.

Sampling, if it must be infrequent, is done best with most nearly accurate results by taking *composite* samples at the following times after calving:

Spring cows, one sample at 6 weeks, and one at 6½ to 7½ months after calving; or two samples at six months after calving.

Summer cows, one sample at 8 weeks, and one at 6 to 7 months after calving; or two samples from third to fifth months after calving.

Fall cows, one sample at 8 to 10 weeks, and one at 5½ to 7 months after calving; or two samples from fifth to seventh months after calving.

When sampling the milk of single cows, pouring several times and immediate dipping should be practiced rather than stirring. The Scovell sampler, which takes a core through the milk, is a very satisfactory device. For large messes some form of the automatic sampler should be used.

6. EFFECT OF ABORTION ON QUANTITY AND QUALITY OF MILK.

For some years past the station herd has been more or less affected by abortion. The cause has not been definitely traced, although some cases were clearly due to accident. Disinfection of the stable and the use of laudanum, as stated in our Sixth report (pp. 114–115), have been resorted to as preventives with a fair degree of success.

The Sixth report contained the results of a study of the effects of abortion on the quantity and quality of milk. Our unfortunate experience since has enabled us to accumulate still more data on this subject. The following tables show:

I. The quantity and quality of milk and butter made by six cows for entire lactations following calving, and for a similar number of days following abortion.

II. The average quality of the milk of eight cows for each of nine months following calving and following abortion.

III. The comparative yields and qualities of milk before and after abortion and after normal calving.

I. QUANTITY AND QUALITY FOLLOWING CALVING AND ABORTION.

COW.	CALVING.			ABORTION.		
	Milk, Lbs.	Butter. Lbs.	Fat. Per cent.	Milk. Lbs.	Butter. Lbs.	Fat. Per cent.
Dora	5,925	360	5.21	3,623	247	5.85
Fanny	4,603	256	4.77	2,760	164	5.09
Flora	7,471	451	5.17	2,926	177	5.19
Idarella	4,102	249	5.18	4,888	303	5.34
Lady Le Brocq	6,036	346	4.92	4,123	299	6.21
Maizie	8,253	445	4.64	5,094	290	4.88
Average	6,115	351	4.93	3,902	247	5.43
Per cent. of amount given after calving.				6	70	110

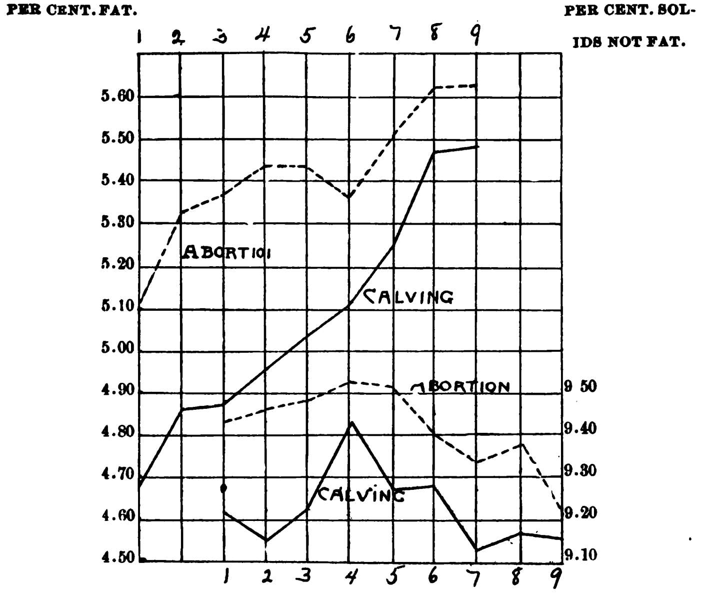
II. MONTHLY QUALITY FOLLOWING CALVING AND ABORTION.

NUMBER OF MONTH.	PER CENT. OF FAT.			PER CENT. OF SOLIDS NOT FAT.		
	Calving.	Abortion.	Increase after Abortion.	Calving.	Abortion.	Increase after Abortion.
1	4.68	5.11	0.43	9.21	9.43	0.22
2	4.86	5.32	0.46	9.15	9.46	0.31
3	4.87	5.36	0.49	9.22	9.48	0.26
4	4.95	5.43	0.48	9.43	9.52	0.09
5	5.04	5.43	0.39	9.27	9.51	0.24
6	5.11	5.35	0.24	9.28	9.40	0.12
7	5.25	5.51	0.26	9.13	9.34	0.21
8	5.47	5.62	0.15	9.17	9.38	0.21
9	5.48	5.63	0.15	9.16	9.21	0.05

III. YIELDS AND QUALITY BEFORE AND AFTER ABORTION, AND AT FULL TIME.

COW.	BEFORE ABORTING.			AFTER ABORTING.			AT FULL TIME.		
	Daily Milk Yield. Lbs.	Fat. %	Solids Not Fat. %	Daily Milk Yield. Lbs.	Fat %	Solids Not Fat.	Daily Milk Yield. Lbs.	Fat. %	Solids Not Fat. %
Dora..........	8	5.88	9.43	13	5.88	9.47	22	5.23	9.44
Fanny.........	10	5.26	9.15	11	5.21	9.31	20	4.41	8.92
Flora.........	Dry.	6.05	9.38	13	4.69	8.95	24	4.30	8.85
Flox..........	10	5.41	9.54	13	4.81	9.57	17	5.03	9.34
Idarella.......	7	5.35	9.39	17	5.27	9.57	20	4.92	9.57
Kinkora	7	5.50	9.42	12	5.47	9.74	23	4.91	9.16
Lady Le Brocq	7	6.19	9.37	14	6.17	9.89	23	5.32	9.28
Maizie.........	9	5.36	9.68	21	4.58	9.20	32	4.31	8.96
Average.....	8	5.63	9.42	14	5.26	9.46	23	4.84	9.19

Table No. 2 is graphically shown herewith.



The main results agree with those given in our Sixth report. In the present cases there was found to be:

1. A shrinkage of over one-third in milk yield.
2. A gain of one-tenth in quality.
3. A shrinkage of nearly one-third in butter yield.
4. A more even quality of milk throughout the milking period.

Table III. shows that the milk flow after abortion was greater than that before abortion, but that it was only about sixty per cent. of what had previously followed normal calving. In five cases out of eight the quality did not change from that given before abortion. In the other three the quality resembled that following normal calving.

In seven cases out of eight the quality of the milk, both as regards fat and solids not fat, was better than that given after normal calving.

The only point in which the results of the former report are not borne out by those now under discussion is in the quality of the milk given in the various months of the lactation period. It is stated in our Sixth report that "while the milk of a cow calving at full time gradually grows richer, as the months pass, the milk of the cows that aborted gradually grew poorer, until by the third month it was just about the same quality that it would have been at the third month after calving, if the cows had gone full time."

There was a gradual but practically constant increase in the fat percentage of the milk of the cows now under discussion, after abortion, from the first to the ninth month. The solids not fat, however, took the downward path after the fourth month.

The herd of the Minnesota station has likewise been tronbled by abortion. A small amount of data only is at hand from this source. In the following table are the records of five cows, for the six months immediately following the normal calving which preceded abortion, and for the six months following the abortion:

	NORMAL CALVING.			ABORTION.		
COW.	POUNDS MILK.	PER CENT. FAT.	POUNDS FAT.	POUNDS MILK.	PER CENT. FAT.	POUNDS FAT.
Beckley..........	2,891	5.89	170.3	2.032	5.84	118.6
Clara............	3,437	4.40	151.2	2,937	4.63	135.9
Rossy	3,784	5.40	142.7	3,765	5.79	153.9
Loxy............	4,181	4.54	189.6	2 736	4.76	130.0
Sully............	3,324	4.41	146.3	3,737	4.68	174.9

Three gave less milk and butter, two more; four gave better milk, one gave milk of the same quality. The differences on the whole were less pronounced than those observed in the Vermont herd.

II. RECORD OF THE STATION HERD FOR 1894–5.

Dairying being the leading industry of Vermont, the station has naturally made investigations along that line a prominent feature of its work. It has been thought, moreover, that results obtained with a herd of moderate priced cows would be more likely to be serviceable than if fancy stock was used. Its herds have been composed mainly of such animals as are within the means of most dairymen, but very few (the registered cows) costing more than from fifty to sixty dollars a head.

One of the aims of the station has been to make from its herd of cows a yearly yield of from 350 to 400 pounds of butter per cow by such methods as any good dairyman might use. This goal was reached with the herd of 1892–94, which it was necessary to slaughter early in 1894 because of tuberculosis. The herd records for 1892 and 1893 * (using the one-sixth conversion factor recommended at the Denver meeting of the Association of American Agricultural Colleges and Experiment Stations), were:

1892 Regular members, 372 pounds, entire herd, 355 pounds.
1893 " " 362 " " " 330 "

After the slaughter of the cows and the disinfection of the barn, another herd was bought, animals being added from time to time until at the present writing, early in 1896, there are forty cows stanchioned in the barn, not one of the herd of 1892–94 being included in the number. Two registered Ayrshires were bought of Hon. C. M. Winslow of Brandon, and a like number from Mr. L. S. Drew of Burlington. Early in 1896 two registered Jerseys were bought of Hon. H. W. Vail of North Pomfret, and a like number of Mr. T. G. Bronson of Hardwick. All others are high grade Jerseys bought in Brookfield, Orange County and vicinity, by Hon. Cassius Peck of the Board of Control.

Thirty-one had been members of the station herd for a year on Nov. 1, 1895. Seventeen (including Rena Myrtle, a registered Ayrshire from the former herd, now [1896] sold) have been members of the station herd for two years, April, '94 - April, '96.

The table on the next page shows the records of the seventeen cows for two successive years. Following this on page 189 will be found a tabulation showing the record of thirty cows for the year November 1, 1894, to October 31, 1895, including not only the production of milk, total solids and butter, but also showing the cost of production of milk, fat and butter from each cow.

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* **Bulletin 33; Sixth Report, p. 120; Seventh Report, pp. 82-83.**

RECORDS OF SEVENTEEN COWS FOR TWO SUCCESSIVE YEARS.

NAME OF COW.	Days in milk.	APRIL 18, P. M., 1894, TO APRIL 18, A. M., 1895.						Days in milk.	APRIL 18, P. M., 1895, TO APRIL 18, A. M., 1896.					
		Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Butter.		Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Butter.
		lbs.	%	%	lbs.	lbs.	lbs		lbs.	%	%	lbs.	lbs.	lbs.
Bess	294	6645	14.39	5.07	955.9	336.9	393.1	345	6009	14.38	5.23	863.9	314.4	366.8
Bettie	365	6100	14.30	5.06	872.4	308.7	360.2	304	6108	13.67	4.66	835.2	284.7	332.1
Brownie	365	5982	14.94	5.59	895.4	334.6	390.4	312	5957	14.72	5.41	876.7	322.5	376.3
Clover	313	5056	15.52	5.69	784.4	287.7	335.7	240	4262	16.11	5.98	686.1	254.5	296.9
Dandelion	307	5055	14.93	5.57	754.6	281.8	328.8	293	4767	14.99	5.58	714.6	265.8	310.1
Dora	309	5265	14.90	5.35	783.9	281.6	328.6	365	4263	15.51	5.95	661.2	253.8	296.1
Fairie	330	5847	13.98	5.09	817.0	297.5	347.1	365	6289	14.61	5.27	918.7	331.7	387.0
Fanny	365	5666	13.76	4.80	778.7	271.7	317.0	365	3607	14.38	5.28	518.0	190.5	222.3
Flora	365	7060	14.19	5.10	1001.6	360.0	420.0	268	3037	14.08	5.34	427.7	162.1	189.1
Golden Rod	254	4158	16.20	6.25	673.4	260.8	304.3	305	4881	16.01	6.39	781.6	311.8	363.8
Jeannie	339	5314	14.21	5.04	755.2	267.6	312.2	316	5068	14.25	5.06	722.3	256.4	299.1
Jessie	297	6411	15.13	5.66	970.1	362.5	422.9	294	5775	15.24	5.82	879.7	335.8	391.8
Julia	326	5746	14.66	5.38	842.2	308.3	359.7	365	5880	15.27	5.68	896.8	333.9	389.6
Maizie	302	7233	13.64	4.51	986.9	325.7	380.0	345	5010	14.60	4.94	731.3	247.3	288.5
Red Top	365	7825	13.86	4.63	1084.5	362.0	422.3	307	6341	13.86	4.64	878.8	294.0	343.0
Rena Myrtle	365	11417	12.40	3.78	1415.5	431.4	503.3	365	4340	12.49	3.81	541.7	165.3	192.9
Rowena	365	6337	13.89	4.72	880.0	298.8	348.6	246	5631	13.85	4.48	779.7	252.3	294.4
Average	331	6301	14.24	5.02	897.2	316.3	369.1	318	5131	14.58	5.25	747.9	269.7	314.1

The average yearly butter yields were 369 and 314 pounds. For thirty-one cows, in 1894-95, it was 325 pounds. The average of the two years' entire herd production in 1892–'93 was 343 pounds; the average of the two years 1894–'95 for all cows kept throughout the two years was 345 pounds.

Of the seventeen cows whose yearly records are compared, three gave more, two the same, and twelve less milk the second year than they did during the first year. Three gave more and fourteen less butter. Eleven gave better, two poorer, and four the same quality of milk during the second lactation. The average shows but 81 per cent. as much milk and 85 per cent. as much butter during the second year as was produced during the first year.

It is not difficult to find the cause for this serious diminution. Dora, Fanny, Flora and Maizie aborted, Rena Myrtle ran farrow throughout the two years, which caused high production (11,417 pounds milk, 503 pounds butter) during the first year, but low production (4,340 pounds milk, 193 pounds butter) during the second year. Bess, Clover and Red Top ran farrow for a year and a half or more, which favored the first year at the expense of the second. The other nine cows gave within one per cent. as much milk and butter the second year as the first. The quality of the milk of these cows did not change (1894–5, total solids, 14.63 per cent.; fat, 5.34 per cent.; 1895–6, total solids, 14.71 per cent.; fat, 5.35 per cent.), while, as has been already pointed out in a previous article, the milk from the cows which aborted was decidedly richer. Two of the farrow cows gave somewhat richer milk during the second year, and two did not change its quality.

RECORD OF THE HERD OF THE VERMONT AGRICULTURAL EXPERIMENT STATION FOR THE YEAR NOV. 1, 1894 — OCT. 31, 1895.

COW.	Approximate weight of cow.	Approximate age, Nov. 1, 1894.	Date of calving, 1894.	Date of calving, 1895.	Days in milk.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Butter.	Cost of food.	Cost of grain.	Cost of 100 lbs. milk.	Cost of 1 lb. fat.	Cost of 1 lb. butter.	Proceeds from butter sales.
						lbs.	%	%	lbs.	lbs.	lbs.	$	$	cts.	cts.	cts.	$
Acme	930	5	Nov. 1	Oct. 4	305	8092	12.94	4.05	1046 7	327.9	382.5	56.23	20.27	69 5	17.2	14.7	89.89
Atalanta	770	5	Oct. 30	Sept. 25	316	6639	12.62	3.85	838.0	255.4	297.9	53.20	19.74	80,1	20.9	17 9	70.01
Bess	1000	8	Oct. 24	Mar. 6 '96	365	7717	14.13	5.13	1090.8	396.2	462.2	56.29	21.56	72.9	14.2	12.2	108.62
Bettie	830	6	*May 5	*July 19	303	5052	13.50	4.76	681.8	240.5	280.6	48.31	16.40	95.7	20.1	17.2	65.94
Brownie	870	5	Sept. 13	Nov. 11	326	4886	15.38	5.81	752.4	284.0	331.3	52.37	18.74	107.2	18.8	15.7	77.86
Clover	1000	7	April	Sept. 24	240	3702	15.88	5.96	588.0	220.7	257.5	49.54	19.85	133.8	22.5	19.2	60.51
Dandelion	750	5	Sept. 23	Oct. 15	296	4522	15.06	5.70	681.1	257.7	300.7	46.21	19.41	102.2	17.9	15.3	70.67
Dora	820	5	Sept. 24	*Aug. 17	365	5693	14.87	5.56	846.5	316.5	369.3	54.61	21.94	96.0	17.3	14.8	86.79
Eulalie	1060	5	Oct. 11	Dec. 2	324	6412	14.57	4.96	934.2	317.9	370.9	48.23	16.05	75.2	15.2	13.0	87.16
Fairie	780	5	April	Mar. 28	330	5585	14.44	5.19	806.4	289.9	338.2	46.04	17.04	82.4	15.8	13.8	78.30
Fanny	1000	5	April	Farrow	365	4043	14.20	5.19	574.1	209.9	244.9	49.63	19.55	122.7	23.5	20.3	57.55
Flora	970	5	April 15	Aug. 12	269	3960	14.49	5.72	573.9	226.3	264.0	43.76	16 91	110 5	19.3	16 5	62.04
Golden Rod	870	3	Oct. 5	Jan. 7 '96	365	5327	16.40	6.67	873.9	355.3	414.5	54.30	20.55	101.9	15.3	13.1	97.41
Goldie	850	8	Sept.	June 21	354	5443	15.13	5.60	823.5	305.0	355.8	52.85	18 94	97.1	17.3	14.9	83.61
Jeannie	810	5	Nov. 23	*Nov. 1	300	3083	14.58	5.23	449.4	161.1	187.9	43.39	17.01	140.7	26 9	23.1	44.04
Jersey Lily	730	3	Sept.	Oct. 18	313	5125	15.03	5.12	770.4	293.1	342.0	45.36	17.73	83 5	15.5	13.3	80.37
Jessaline	820	4	Sept.	*April 18	365	5593	13.58	4.81	758.5	269.0	313.8	49.06	19.89	87.7	18.2	15.6	73.74
Jessie	850	5	Oct. 13	Nov. 28	326	6890	15.24	5.70	1051.2	392.3	457.7	53.91	19.13	78.2	13.7	11.8	07.56
Julia	800	5	April	April 9	326	5341	15.02	5.57	802.0	297.5	347.1	43.28	17.69	81.0	14.5	12.5	81.57
Kinkora	800	5	Dec. 19	*Nov. 18	311	4871	14.14	5.14	688.5	250.0	291.7	46.28	16.48	95.0	18.5	15.9	68.55
Lady Le Brocq	790	5	Sept.	*Sept. 20	358	5829	15.09	5.64	879.4	329 0	383.8	49.08	17.61	84.2	15.0	12.8	90.19
Maizie	875	8	June 18	July 29	345	6384	14.02	4.76	895.1	303.9	354.6	55.81	21.87	87.4	18.3	15.8	83.33
† *Nancy B.*	950	7	Sept. 15	July 18	345	7831	12.88	3.90	1008.6	305.5	356.4	55.65	21.30	71.1	18.2	15.6	83.75
† *Nett*	1020	6	Nov. 1	Sept. 24	318	8437	12.99	3.99	1095.8	337.0	393.2	54.47	20 88	64.6	16.2	13.9	92.40
Portelette	870	6	Sept.	Dec. 6	353	6140	13.64	4.55	878.4	292.8	341.6	51.42	17.18	79.8	17.6	15.1	80.28
Red Top	865	5	April 1	Oct. 26	296	4960	14.03	4.90	696.1	243.1	283.6	55.23	17.71	111.2	22.7	19.5	66.65
Regina	725	5	Sept.	Dec. 26	365	5372	13.22	4.27	710 2	229.6	267.9	48.03	18.42	89.4	20.9	179	62.96
Rena Myrtle	1100	7	Far	row	365	7466	2.27	3 74	915.5	279.2	325.7	Rec	ord	not	ke	pt.	
Rhoda	850	5	Sept.	July 30	316	5015	14.23	4.87	713.8	244 1	284.8	48.40	18.21	196.5	19.8	17.0	66.93
Rowena	830	3	April	Sept. 18	246	4022	13.22	4.49	531.9	180.7	210.8	47.68	20.08	118 5	26.2	22.5	49.54
Waxy	700	5	Sept.	———	298	4892	13.93	4.74	681.4	232.1	270.4	43.19	17.39	88.3	18.6	15 9	63.64
Average					325	5633	14.11	4.95	794.8	278.8	325.3	50.06	18.85	93.6	18.5	16.2	76.40

Cows' names in *italics* are registered Ayrshires; all others are high grade Jerseys.

† At farm but 358 days; all others, 365 days.

*** Aborted.**

Excluding Rena Myrtle, whose feeding record is faulty, the averages are: Days in milk, 324; pounds of milk, 5,572; per cent. of total solids, 14.19; per cent of fat, 5.00; pounds of total solids, 790.7; pounds of fat, 278.8; pounds of butter, 325.3.

The following table shows the relative ranks of the thirty cows as regards the production and cost of milk and butter.

	AMOUNT OF MILK.	AMOUNT OF BUTTER.	COST OF MILK.	COST OF BUTTER.
1	*Nett*	Bses	*Nett*	Jessie
2	*Acme*	Jessie	*Acme*	Bess
3	*Nancy B*	Golden Rod	*Nancy B*	Julia
4	Bess	*Nett*	Bess	Lady Le Brocq
5	Jessie	Lady Le Brocq	Eulalie	Eulalie
6	*Atalanta*	*Acme*	Jessie	Golden Rod
7	Portelette	Eulalie	Portelette	Jersey Lily
8	Eulalie	Dora	*Atalanta*	Fairie
9	Maizie	*Nancy B.*	Julia	*Nett*
10	Lady Le Brocq	Goldie	Fairie	*Acme*
11	Dora	Maizie	Lady Le Brocq	Dora
12	Jessaline	Julia	Maizie	Goldie
13	Fairie	Jersey Lily	Jessaline	Portelette
14	Goldie	Portelette	Waxy	Dandelion
15	Regina	Fairie	Jersey Lily	Jessaline
16	Julia	Brownie	Regina	*Nancy B*
17	Golden Rod	Jessaline	Kinkora	Brownie
18	Jersey Lily	Dandelion	Bettie	Maizie
19	Bettie	Kinkora	Dora	Kinkora
20	Rhoda	*Atalanta*	Rhoda	Waxy
21	Red Top	Rhoda	Goldie	Flora
22	Waxy	Red Top	Golden Rod	Rhoda
23	Brownie	Bettie	Dandelion	Bettie
24	Kinkora	Waxy	Brownie	*Atalanta*
25	Dandelion	Regina	Rowena	Regina
26	Fanny	Flora	Flora	Clover
27	Rowena	Clover	Red Top	Red Top
28	Flora	Fanny	Fannie	Fannie
29	Clover	Rowena	Clover	Rowena
30	Jeannie	Jeannie	Jeannie	Jeannie

It will be noticed that usually the cows giving the most milk and butter made it most cheaply, and that those giving the least milk or butter made it at the greatest cost. Registered Ayrshires and Jersey grades alone are represented. The four Ayrshires (italicized in the table) rank first, second, third, and sixth in milk production, and first, second, third, and eighth in economy of milk production. In butter production they rank fourth, sixth, ninth and twentieth, and in economy of butter production, ninth, tenth, sixteenth and twenty-fourth. As has been hitherto clearly shown, they are pre-eminently the milkman's cow, ranking much higher in economy of milk making than in cheapness of butter production.

The following table shows the extremes in quantity and cost of product in the herd:

	LOWEST AMOUNT FOR ANY COW.	HIGHEST AMOUNT FOR ANY COW.	RATIO OF LOWEST TO HIGHEST.
Pounds of milk	3,083	8,437	1 : 2.74
Per cent. of total solids...	12.27	16.40	1 : 1.33
" " fat...........	3.74	6.67	1 : 1.78
Pounds of total solids...	449.4	1,095.8	1 : 2.44
" fat........	161.1	396.2	1 : 2.46
" butter..........	187.9	462.2	1 : 2.46
Cost of feed........	$43.19	$ 56.23	1 : 1.30
" grain......	$16.05	$ 21.94	1 : 1.37
" 100 pounds milk...	$ 0.646	$ 1.407	1 : 2.18
" 1 pound fat	$ 0.137	$ 0.269	1 : 1.96
" 1 pound butter. ...	$ 0.118	$ 0.231	1 : 1.96
Value of butter product at actual selling price.....	$ 44.04	$108.62	1 : 2.47

No special effort was made to select or to feed an economical ration or to obtain extraordinary results. Nearly all these cows were used in feeding experiments and subjected to many changes of ration. In some cases, indeed, distasteful rations were experimentally used to the manifest detriment of maximum production. In order to get some basis on which to judge the money value of the foods eaten, a number of prominent and successful farmers in various parts of the state were asked to give the station their estimate of the money value of the various food materials in their own localities. The values used are the averages found from these returns.

The fodders and feeds used were:

Wheat bran, corn meal, cob meal, cotton seed meal, linseed meal, king gluten meal, Chicago maize feed, hay, corn ensilage, corn fodder, corn stover, stover ensilage, green peas and oats, green millet, green fodder corn, pasture, and small quantities of a few experimental fodders. The rations were usually made such as the cows would eat without waste. But little grain was fed during the summer. The largest amount of grain regularly fed was eight pounds daily, usually either half corn meal and half bran, or a mixture made up of 3 lbs. bran, 2 lbs. corn meal, 1½ lbs. cotton seed and 1½ lbs. linseed meals. The cows were pastured from May to late in October during the day time. During the winter they were out in the yard more or less every day according to the weather.

It should be remarked that the exact distribution of the fodders and feeds among the cows cannot be given, the records being somewhat incomplete. Neither are the sums indicated as cost of food fed each cow exact, for the same reason and because of the impossibility of fixing definite prices upon roughages which are but seldom sold on the market. They are, however, the result of very conservative estimates and careful computation from much, if not full, data, and are believed to be sufficiently close approximations to the truth to warrant their publication.

III. TESTS OF DAIRY APPARATUS.

The results of a series of steam consumption tests made by Prof. A. W. Ayer, of the Mechanical Department of the University of Vermont and State Agricultural College were given upon pages 155–160 of the Eighth report of this station. The machines tested were the United States No. 1 Belt Separator, and the De Laval Alpha Turbine Separator. A series of tests with the De Laval Alpha Belt Separator were made this year, under as nearly as might be similar conditions as those which existed in the former tests. The same engine, condenser, etc., were in use, and the same operator was in charge. The results obtained are shown in the accompanying table:

TESTS TO DETERMINE THE STEAM CONSUMPTION OF THE DE LAVAL ALPHA NO. I BELT SEPARATOR.

DATE.	DURATION OF TEST.	WEIGHT OF MILK, LBS.	SPEED OF SEPARATOR.	TEMPERATURE OF MILK.	PER CENT. FAT IN SKIM MILK.	STEAM USED, LBS.	HORSE POWER DEVELOPED BY ENGINE.	STEAM PER H. P. PER H'R, LBS.	LBS. MILK SKIMMED PER LB. STEAM.	STEAM TO SKIM 1,000 LBS. MILK.	BOILER PRESSURE.	RATE OF SEPARATION, LBS. PER HOUR.
Feb. 18.......	17 m. 24 s.	672.5	5,600	85°	0.04	31.0	1.52	70.36	21.69	46.10	70	2,320
Feb. 19.......	16 m. 8 s.	666.0	5,600	83°	0.05	29.75	1.70	65.12	22.39	44.67	70	2,478
Feb. 20.......	15 m. 55 s.	693.0	5,800	80°	0.07	29.5	1.63	68.22	23.49	42.47	75	2,612
Feb. 21.......	16 m. 50 s.	678.5	5,600	78°	0.07	28.25	1.58	64.15	24.02	41.64	70	2,419

It appears that in these tests the Alpha Belt machine used but about two-thirds as much steam as the United States Belt Separator to separate the same amount of milk, under as nearly similar conditions as were obtainable, and that the De Laval Turbine Separator was much more wasteful of steam than either of the others, a condition which appears characteristic of steam motor machines in general.

The averages of the three machines are shown in the following table:

	Number of tests.	Speed of Separator.	Boiler pressure, pounds per square inch.	Pounds of steam used.	Pounds of milk used.	Temperature of milk.	Pounds of milk per hour.	Per cent. fat in skim milk.	Pounds of milk separated per pound of steam.	Pounds of steam required to separate 1000 lbs. milk.	Horse power developed by engine.	Pounds of steam used per horse power per hour.
DeLaval Turbine.	5	5730	935	79.5	1074	72	2548	0.03	13.26	75.4	—	—
United States Belt	4	7300	70	46.6	716	81	2531	00.5	15.37	65.1	2.69	61.3
DeLaval Belt.....	4	5650	71	29.6	678	82	2457	0.06	22.90	43.7	1.61	67.0

IV. FAST AND SLOW MILKING.

The result of slow milking is usually thought to be a loss in milk and butter. A test of this matter was made during the summer, the eight cows under experiment being milked throughout by one person to whom they were accustomed. The slow milking took from two to two and one-half times as long as the rapid milking. Four of the cows were in fairly full flow while the other four were either strippers or upon the verge of stripping.

NAME OF COW.	JULY 5-13. FAST MILKING.					JULY 13-21. SLOW MILKING.					JULY 28-AUG. 5. FAST MILKING.				
	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.
	lbs.	%	%	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	%	%	lbs.	lbs.
Jessaline....	105.6	13.69	5.12	14.45	5.40	99.3	13.57	5.10	13.48	5.07	97.3	13.65	5.25	13.27	5.11
Goldie	158.8	14.76	5.29	23.44	8.39	153.8	14.53	5.35	22.35	8.22	142.7	14.31	5.30	20.42	7.56
Golden Rod	104.9	16.02	6.77	16.26	7.10	96.8	15.98	6.80	15.47	6.58	87.7	16.29	7.05	14.29	6.18
Bess.........	148.6	13.83	5.10	20.56	7.58	143.0	13.64	4.95	19.51	7.07	127.9	13.49	4.95	17.25	6.33
Portelette ..	149.6	13.88	4.79	20.75	7.16	128.1	13.88	4.78	17.78	6.12	73.5	14.78	5.40	10.87	3.97
Eulalie	144.5	14.31	5.17	20.61	7.45	122.0	14.52	5.40	17.71	6.59	94.7	14.58	5.38	13.81	5.09
Dora	100.4	15.77	5.96	14.25	5.39	69.0	15.97	6.24	11.03	4.31	51.4	16.83	6.75	8.65	3.47
Kitty.........	92.4	15.62	5.98	16.51	5.48	78.2	16.00	6.19	12.54	4.84	50.3	17.11	7.30	12.49	3.67

A study of the table shows for the cows giving full flow:

(1) A diminution in the milk flow from one period to another.

(2) Essentially unchanged quality.

It is quite clear, however, that the lessened yield is due to weather conditions, drying pastures, advancing lactation, etc., rather than to slow milking as may be seen by the following gross yields for successive eight-day periods during the summer: Pounds of milk, 580, 546, 518, 493, 481, 456. Two of the strippers dried off in a month after the slow milking ceased, the other two, a couple of months or more later. How much effect, if any, the slow milking had in lessening the yield cannot be told because of the natural shrinkage due to the time of year. Quality seems to be somewhat bettered, yet the per cent. of fat in the milk given in the third period would indicate that the changes were not due to slow milking.

Experiments by Babcock* on nine cows showed no loss in quantity of milk, but ten per cent. shrinkage in total butter product. All the cows gave poorer milk when milked slowly, although in three cases the difference was but slight. Dr. Babcock remarks that in most cases where loss has followed the prolongation of the time of milking, the cow has been subjected to change of milker as well as to change in the rate of milking. The effect upon quality in his work is very different from that observed in our experiments.

Notwithstanding the negative results obtained in our work, the argument against slow milking is not lessened, since time is money.

V. MISCELLANEOUS FODDER CROPS.

The series of experimental plots, mentioned in our Eighth report (p. 168), was planted again, with some extensions, during the season of 1895. Several of the crops planted upon these plots (the soil of which was of a clayey loam nature) were also grown elsewhere upon the station farm upon a sandy loam garden soil. Each location was well fertilized.

The tables on the following pages show:

I. Analyses of the crops.

II. Pounds of dry matter and food ingredients per acre in the various crops.

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*Wis. Agr. Expt. Station, Sixth Report, 1889, p. 48.

I. ANALYSES OF EXPERIMENTAL CROPS.

STATION NUMBER.	CROP.	METHOD OF PLANTING.	SOIL.	ORIGINAL SUBSTANCE.		COMPOSITION OF DRY MATTER.							
				Water.	Dry Matter.	Crude Ash	Crude Protein.	Crude Fiber.	Nitrogen—free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid	Potash.
3,601	Japanese Millet; Cock's-foot	Drilled	Clay loam	78.88	21.12	8.82	10.89	28.79	49.20	2.30	1.75	0.561	2 378
3,602	" " " "	"	Sandy loam	69.92	30.08	8.66	7.02	27 83	54.39	2.10	1.12	0 585	2 567
3,603	" " " "	Broadcast	" "	72.26	27.74	7.70	5.69	30.99	53 30	2.32	0.91	0.490	1.942
3,604	" " Panicle....	Drilled	" "	71.53	28.47	7.51	8.29	26.74	55 27	2.19	1.32	0.457	2.690
3,605	" " "	Broadcast	" "	68.49	31.51	7.03	6.76	29 39	54.69	2.13	1.08	0.408	2.469
3,608	Hungarian Millet............	"	Clay loam	66.46	33.54	10.75	12.39	32 30	41.80	2.75	1.98	0.434	3.372
3,506	Cow Pea, "Calico"..	Drilled	" "	84.93	15.07	14.59	23.78	21 12	37.27	3.24	3.80	0.763	3 756
3,507	" "Extra early".....	"	" "	82.71	17.29	12.80	22.38	22.07	39 98	2.77	3.58	0 643	3 561
3,508	" "Manikin"........	"	" "	83.09	16.91	11.91	17.43	23.19	42.41	5.06	2.79	0.633	2.763
3,509	" "Whippoorwill"..	"	" "	83.97	16.03	14.19	19.38	23.57	38.02	4.84	3.11	0.723	3 069
3,500	Soja Bean, white.....	"	" "	70.88	29.12	8.65	22.23	21.86	39.40	7.86	3.56	0 784	2 202
3,501	" "	"	Sandy loam	64.75	35.25	8.31	19.88	28.15	36.05	7.61	3.18	1.082	2.000
3,502	" green.............	"	Clay "	75.24	24.76	10.02	14.86	26.33	42.38	6.41	2.37	0.873	2.388
3,503	" "	"	Sandy "	73.63	26.37	10.16	19.90	26.50	38.29	5.15	3.19	0 651	2.203
3,504	" black..............	"	Clay "	74 62	25 38	9 54	16.94	23.24	45 19	5.09	2.71	0.652	2 599
3,505	" "	"	Sandy "	74.28	25.72	10.38	16.30	28.12	41.64	3.56	2.61	0.794	3 199
3,597	Flat Pea........................	Broadcast	Clay "	72.64	27.36	5.74	23.17	29.09	38 39	3.61	3.72	0.595	1.417
3,596	Spring Vetch and Oats......	"	" "	75.64	24 36	9.41	14.75	25.07	46.50	4.27	2.36	0.648	2.850
3,600	" " "	"	Sandy "	74 17	25 83	9.36	13.35	29.87	44.68	2.74	2.18	0.562	2 490
3,595	Winter Vetch and Oats.....	"	Clay "	74.79	25.21	9.46	15 72	26.65	43.99	4.18	2.51	0.608	2.325
3,599	" " "	"	Sandy "	70.83	29.17	8.22	14 56	25.95	47.00	4.27	2.75	0.604	2.151
3,613	Bokhara Clover	"	Clay "	71 33	28.67	8.46	11.76	27.79	49.09	2.90	1.89	0.539	2.043
3,607	Crimson "	"	" "	74.33	25.67	9.63	14.56	31 67	41 52	2.62	2.33	0.616	3.344
3,606	Alsike "	"	" "	74.12	25.88	10.13	15.98	27.11	43.36	3.41	2.56	0.613	3.523
3,493	White "	"	" "	79.35	20.65	13.00	21.20	17.94	43.62	4.24	3.39	0.761	3.981
3,594	Wild Vetch.......	"		66.26	33 74	6.41	21.59	31.91	37.00	3.09	3.47	0.682	2.422
3,598	Oats and Peas................	"	Sandy "	71.27	28.73	6.74	12.61	29.56	47.27	3.82	2.02	0.444	2.237

II. POUNDS OF DRY MATTER AND FOOD INGREDIENTS PER ACRE.

CROP.	METHOD OF PLANTING.	POUNDS OF										
		Green Fodder.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen—free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Japanese Millet; Cock's-foot,	Drilled	36050	28438	7612	671	828	2191	3747	175	133	43	181
" " " "	"	19250	13460	5790	501	406	1612	3149	122	65	34	149
" " " "	Broadcast	38000	27460	10540	812	600	3267	5617	244	96	52	205
" " Panicle ...	Drilled	17200	12303	4897	368	406	1310	2706	107	65	22	132
" " " ...	Broadcast	21800	16988	7812	549	528	2296	4273	166	84	32	93
Cow Pea "Calico"..........	"	15225	12930	2295	335	546	485	855	74	87	17	86
" " "Extra Early"...	Drilled	13125	10855	2270	291	508	501	907	63	81	15	81
" " "Manikin".	"	12750	10594	2156	257	376	500	914	109	60	14	60
" " "Whippoorwill".	"	8340	7003	1337	190	259	315	508	65	42	10	41
Soja Bean, white............	"	12100	8576	3524	305	783	770	1388	277	125	28	78
" " "	"	3850	2493	1357	113	270	382	489	103	43	15	27
" " green...........	"	23500	17682	5818	583	864	1532	2465	372	138	51	139
" " "	"	15050	11081	3969	403	790	1052	1520	204	127	26	87
" " black	"	15800	11790	4010	383	679	932	1812	204	109	26	104
" " "	"	10940	8128	2812	292	458	791	1171	100	73	22	90
Flat Pea..........................	"	13420	9748	3672	211	850	1068	1410	133	137	22	52
Spring Vetch and Oats.....	Broadcast	20640	15612	5028	473	741	1261	2338	215	119	33	143
" " " "	"	14760	10947	3813	357	509	1139	1704	104	81	21	95
Winter " " "	"	19765	14783	4982	471	783	1328	2192	208	106	28	124
" " " "	"	19800	14024	5776	475	841	1499	2715	246	159	35	124
Bokhara Clover..............	"	9850	7026	2824	239	332	785	1386	82	53	15	58
Crimson "	"	15980	11878	4102	395	597	1299	1704	107	96	25	137
Alsike "	"	9600	7117	2483	251	397	673	1077	85	64	15	87
White "	"	8250	6547	1703	221	361	306	743	72	58	13	68
Peas and Oats................	"	38000	27083	10917	736	1376	3227	5161	417	214	47	237

MILLETS.

Japanese or Cock's-foot Millet (*Panicum Crus-galli*). Panicle or "Broom Corn" Millet (*Panicum miliaceum*). "Common" Millets (*Setaria Italica*, varieties).

These millets were grown from seed received from the Massachusetts station from strains originally from Japan. They were grown at this station in 1893, but did not make as favorable a showing as this year. The seed stalk of the cock's-foot millet resembles that of an enormous barn-grass, while that of the panicle millet droops like the head of the broom corn.

Brooks* reports growing upwards of ten tons of green fodder to the acre, and that "the food value of the product of an acre in millet has often exceeded the food value of an equal area of similar land in corn." In the present cases very rank growths were obtained on five different plots, yielding at the rate of *from eight and one-half to nineteen tons of green fodder and from two and one-half to five and one-quarter tons of dry matter to the acre*. The millets are rapid growers and make an impressive showing when standing in the field ready for cutting. The per cent. of protein, however, is lower even than that of the corn plant, lower than that of almost any other agricultural crop, hence its magnificent growth is not helpful in the way of balancing rations. The cock's-foot millet was probably developed from the common barnyard grass, but differs from it in several important characteristics, tillering profusely, making taller growth, and being more leafy. Better results were obtained by broadcasting than by sowing in rows, the labor of cultivation being obviated and larger yields obtained. The quality was slightly poorer, however. Cattle ate the various millets readily, leaving the butts only when the nearly ripe plant was fed.

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* Hatch Expt. Station, Fifth Report, pp. 151–152.

Hungarian.German or Hungarian millet (*Setaria Italica var. Germanica*). This variety is smaller than the Japanese and has a dense, compact, erect head. It grew this year less luxuriantly than the other millets, yet owing to its higher protein contents the gross yield of this most valuable nutrient was on a par with that of the other millets.

Crozier† summarizes a bulletin on millet as follows:

"Millet is used chiefly as a 'catch crop' for hay, since it can be sown in spring whenever it is discovered that a seeding of the permanent grasses has failed, or that a hard winter or insects have destroyed the clover. It may be sown when too late to plant corn."

"Millet requires good soil, preferably sand, and is especially adapted to new land. Sow half a bushel per acre for hay, one peck if for seed."

"Millet hay is usually cured by cocking it up when partially dry and allowing it to stand for several days before being hauled to the barn, as is often done with clover."

"Millet hay is strong feed and should be used with caution, being alternated, if practicable, with other fodder, especially if fed to horses. It is safer and more palatable if cut before the seed begins to ripen."

"The best variety is German Millet, providing the soil is good and it can have the entire season. For late sowing, or poor soil, use common millet. Hungarian grass on fertile soils in a moist season, will give a large yield of excellent fodder."

He likewise states that although used in this country almost wholly as a fodder for horses and cattle, in many localities in the old world several varieties are grown for seed, which is used for human food. It is estimated that a third part of the inhabitants of the globe, notably the Chinese and Japanese, feed upon various kinds of millet.

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† Mich. Agl. Expt. Station, Bul. 117

COW PEAS (*Vigua [Dolichos] Katiang var. Sinensis.*)

The First Annual Report of this station, pp. 73–78, contains the account of cultural experiments with this crop, made on twenty-six farms in various parts of the state under station auspices. The result was that "reports from thirty farmers show that the crop made a medium growth in twelve cases, and a failure in twelve cases, the rest being indeterminate. Five only out of the whole number think there is a chance that it would pay them to raise it as a regular farm crop, while eleven farmers very strongly pronounce it inferior to corn as a fodder plant."

Because of the great value of this plant in localities where it can be grown, and because more or less success has been attained in southern New England with cow peas, it was thought best to try once again to grow the crop. The peas were planted in early June (to avoid the possibilities of early frosts), and harvested October 1, the tops being just barely touched by frost. Seed was well formed but not ripened on the "Extra Early" and "Calico" varieties. These two varieties also made the best growth and richest fodder. Judging from but a single year's experience, the cow peas presented no advantage over soja beans except that of growing, in two cases, slightly richer fodder.

The yield of dry matter was at best less than half, and the yield of protein less than two-thirds those given on the soja bean plots. The latter crop grew with as little attention, was harvested with greater ease, and is well relished by cattle.

SOJA BEANS (*Soja hispida; Glycine hispida.*)

The soja beans are annual leguminous plants, growing three to four and one-half feet high, bearing clustered pods. They have been successfully grown at this and other stations in past years, and results reported. The crop may be fed green, ensilaged or hayed, and is well relished by cattle. Three varieties, white, green and black, were grown in 1895. The latter two, in particular, made good growths. The white is usually raised for its seed only. The yields ranged at the rate of from 2 to 11¾ tons of green fodder, and from ⅔ of a ton to 3 tons of dry matter per acre. The smaller yields were made by the white variety, and were due to over-ripeness. If planted with corn this crop may prove of considerable value. The mixed ensilage is palatable, and probably has a somewhat greater feeding value.

FLAT PEA (*Lathyrus sylvestris.*)

This perennial leguminous plant has attracted considerable attention for some years past, reports varying from great success to utter failure.

It is claimed that large yields of rich fodder may be cheaply grown for successive years, but the crop is admitted to be slow in germination and growth, and hard to harvest or eradicate. It does well on poor and sandy soils and in drought, rooting very deeply. If cut when past the flowering stage it is not relished by cattle; if cut while flowering it is eaten fairly well, but not eagerly.

The first year's growth with us was spindling, as is always the case The second year's crop produced at the rate of 6¾ tons of green fodder, 1¾ tons of dry matter, and nearly one-half ton of crude protein per acre. The third year's (1896) crop was quite as large as was its predecessor. The crop needs considerable attention the first year lest it be smothered out by weeds, but usually the second, or at the latest, the third year, it grows rankly, making a tangled mass nearly or quite waist high. Its perennial habit is one of its greatest virtues.

*FLAT PEA *(Lathyrus sylvestris).*

It has not, however, always commended itself to feeders, and further experience with it must be obtained before unqualified approval should be given. It analyzed higher in protein than any other of the experimental crops grown during 1895.

OATS AND PEAS.

This well-known combination is still too little grown by Vermont farmers. A glance at the table of analyses and yields shows that it compares well with any of the other crops tried. The entire field is estimated to have

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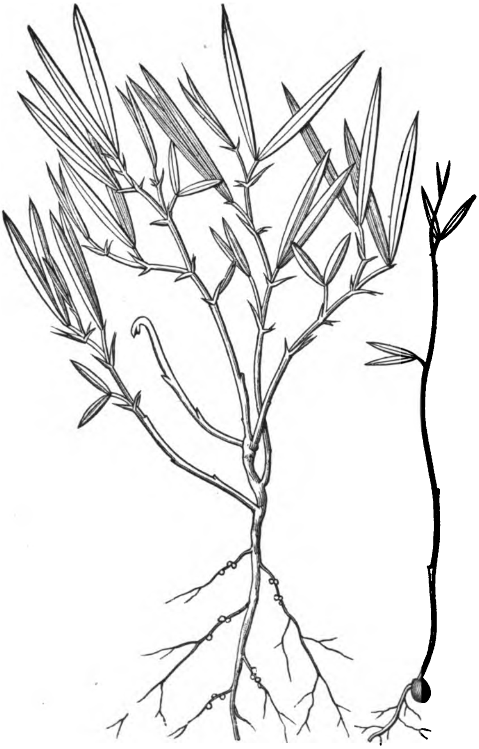
* **This and succeeding cuts are taken from Bulletin No. 2, Division of Agrostology, U. S. Department of Agriculture.**

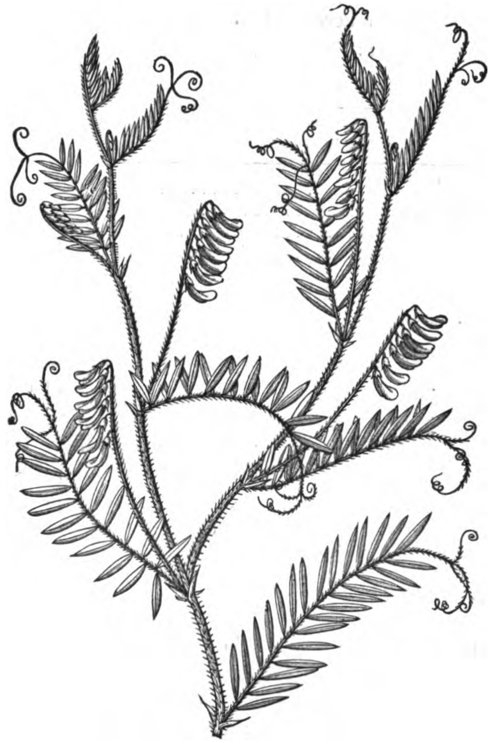


FLAT PEA (*Lathyrus sylvestris*), SHOWING TUBERCLES ON ROOTS.

yielded at least three-fourths as well as the part which was included in the experiment.

SPRING AND WINTER VETCHES AND OATS (*Vicia sativa*, *Vicia villosa*.)

These crops have been grown on the station farm for several years experimentally, and have usually given good satisfaction. In the present cases yields have been obtained at the rate of from 7¼ to 10½ tons of green fodder, from 2 to 3 tons of dry matter, and from 500 to 850 pounds of protein per acre. We have not, however, seen wherein vetch and oats are superior to peas and oats, of which greater tonnages can usually be grown in the same time, and at no greater expense.



HAIRY OR VILLOUS VETCH (*Vicia villosa.*)

[BOKHARA OR SWEET CLOVER (*Melilotus alba.*)

BOKHARA OR SWEET CLOVER (*Melilotus alba.*)

This is primarily a bee plant, very welcome to them, but highly distasteful to all other farm life. It was utterly refused by cattle. It is not infrequently grown to turn under as green manure and is well adapted for the purpose.

CLOVERS.

Red (*Trifolium pratense*); Mammoth red (*Trifolium medium*); Crimson (*Trifolium incarnatum*); Alsike (*Trifolium hybridum*); White (*Trifolium repens*).

The clovers made good growths except the white. Through inadvertence no samples of the first two were taken.

The green weights per acre and hay weights (assuming ten per cent. moisture in the hay) were:

	GREEN.	HAY.
Red clover		
Mammoth red clover		
Crimson clover	15,980 lbs.	4,550 lbs.
Alsike clover	9,600 "	2,780 "
White clover	8,250 "	1,890 "

These clovers are so well known that no reference need be made to any but the Mammoth and Crimson, except for the purpose of calling attention to the comparative yields. Mammoth clover makes a larger, coarser growth than red clover, but otherwise does not differ materially. It is more difficult to cure. There is reason to doubt whether our seed was true to name, and whether or not we did not really have two plots of red clover.

Crimson clover is an annual, bearing long, bright, crimson blossoms. It has proved a most valuable forage plant in states further south, and when sown in the spring does well in Vermont, as the table in the present article indicates. Several plots sown in the summer, which went under the snow in fine shape, were entirely missing in the spring, not a plant surviving. At some points in Connecticut, in New Jersey and further south, it has proved very successful, as hardy as red clover, and perhaps better than almost any other available crop for early pasture, soiling, or green manure. It is greatly to be regretted that equally favorable results cannot be reported for Vermont.

COMPARISON OF GROWTHS ON CLAY LOAM AND SANDY LOAM SOILS.

It was stated at the outset that many of the crops were grown on two different soils. On scanning results it is found that with a single exception the larger yields, the higher per cent. of protein and fat, but the less per cent. of dry matter were obtained on the clay loam soil, the statement being true of all the various crops. The clay soil had been in sod up to the year before, and the sand soil had been cropped for many years. Both were fairly well fertilized.

VI. FEEDING TESTS.

SUMMARY.

Thirty-one cows were used in feeding trials during the winter of 1895–96. These trials lasted for twenty weeks, and were divided into five four-week periods. The first ten days of each period were considered preparatory, and the last eighteen experimental. Full records of the quantity and quality of the food eaten and the milk given were kept throughout.

The results obtained may be briefly stated as follows:

1. *Corn Ensilage vs. Beets*, five cows.—A pound of dry matter gave essentially the same returns when ensilage was fed as when it was replaced by a similar amount from beets. Since the dry matter of ensilage is less digestible than that of beets, it follows that a pound of digestible dry matter from corn ensilage yielded better returns than a similar amount from the beets. It has been amply proved elsewhere that beets cost more and yield less per acre than corn, and the results reported herewith confirm previous tests in showing that, per pound of dry matter, they produce no more and no better milk than corn ensilage.

2. *Corn Ensilage vs. Carrots*, three cows.—The dry matter of ensilage and carrots was found to have essentially equal feeding values. Since the dry matter of carrots is nearly all digestible, it follows that the digestible dry matter of ensilage yielded better returns than that from carrots.

3. *Beets vs. Carrots*, two cows.—A pound of total and of digestible dry matter in the carrot ration produced two-fifths greater yield than a similar amount in beets.

4. *Corn Oil Cake vs. Corn Meal and Bran*, six cows.—A pound of dry matter in corn oil cake produced a twelfth more yield than a similar amount in corn meal and bran.

5. *Atlas Gluten Meal vs. Corn Meal and Bran*, six cows.—A pound of dry matter in Atlas gluten meal produced an eighth more milk and a sixth more butter than a similar amount in corn meal and bran.

6. *Cotton Seed Bran vs. Corn Meal and Bran*, four cows.—A pound of dry matter in cotton seed bran produced less milk and butter than a similar amount in corn meal and bran, but on the basis of digestible dry matter was probably somewhat superior.

7. *Atlas gluten meal* alone changed the quality of the milk. When this feed was used, a slightly richer milk and somewhat narrower ratio of fat to solids not fat resulted. The change was too slight to lay stress upon.

8. *Experimental error in feeding cows*, five cows, the ration remaining unchanged in character.—A pound of total dry matter produced no more milk and butter at one time than at another, lactation stages being equalized. It is thought, however, that when but few animals are used in feeding trials, changes in product of at least four or five per cent. should occur before the results can be safely declared to be due to changes in feeding.

INTRODUCTION.

The feeding tests of the winter of 1895–96 included thirty-one animals, a larger number than had been used hitherto in any one year at this station. The following comparisons of feeding values were made:

1. Corn ensilage vs. beets, five cows.
2. Corn ensilage vs. carrots, three cows.
3. Beets vs. carrots, two cows.
4. Corn and bran (equal parts by weight) vs. corn oil cake, (two parts) corn meal and bran, (each, one part), six cows.
5. Corn and bran (equal parts by weight) vs. Atlas gluten meal (two parts), corn meal and bran (each, one part), six cows.
6. Corn and bran (equal parts by weight) vs. cotton seed bran (six parts), corn meal and bran (each, one part), four cows.
7. In addition to these a study of the probable error inherent in feeding experiments was made by feeding five animals the same throughout the winter, making, however, all weights, records, analyses, etc., just as if they were in a regular feeding trial, and determining what differences, if any, were found from period to period of as nearly as might be identical feeding.

The tests, on the whole, went through in very satisfactory shape. It could hardly have been expected that thirty-one cows, especially when subjected to radical changes in the character of their food from time to time, could continue throughout the winter without some sickness. Lena (ensilage and beets) was killed during the latter part of the winter because of general unthriftiness, due to fibrous phthisis and catarrhal bronchitis,* resulting from a slight pneumonia contracted during the previous winter. Lady LeBrocq (ensilage and carrots), and Jeannie (cotton seed bran and corn and bran), were each for a short time off feed.

FEEDING.

Each feeding period was four weeks long. The first ten days were considered preliminary, in order to get the animal used to her changed ration.

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*This cow was judged by scores of farmers, visiting the station farm, to be surely tuberculous. Repeated injections of double doses of tuberculin failed to produce a reaction, which indicated tuberculosis. In view of the fact that she was an unprofitable animal, exhibiting many symptoms of tuberculosis, having come from a tuberculous herd, (although according to the tuberculin test not herself tuberculous), it was deemed advisable to kill her, to make a careful *post mortem* examination, and to satisfy both the public and ourselves as to the exact cause of her cough, labored breathing, and general unthriftiness. Extreme care and prolonged search failed to disclose the slightest trace of tuberculous lesions.

The results obtained and conclusions deduced are based upon the records of the last eighteen days of each feeding period, which alone were considered experimental. All feeding and milk records, however, were kept daily throughout both portions of each feeding period.

There were five feeding periods of four weeks each. The ten cows on the root feeding tests and two of the cows used in the determination of experimental error were fed during the first four periods only.

NUMBER.	PRELIMINARY.	EXPERIMENTAL.
I.	December 2—12.	December 12–30.
II.	December 30—January 9.	January 9–27.
III.	January 27—February 6.	February 6–24.
IV.	February 24—March 5.	March 5–23.
V.	March 23—April 2.	April 2–20.

All the cows were fed twice a day, watered twice, and, unless extremely cold or stormy, turned out in the yard once daily for from 20 to 35 minutes.

Hay and grain were fed the first thing morning and evening, and after that was eaten each cow received her experimental fodder, if eating such, or ensilage. The amounts of fodder and feed given each cow were weighed, and the orts were weighed back daily and their general nature noted.

The following statements show the general daily feeding plan:

Ensilage and roots.—Hay, 8 pounds; mixed feed, 6 parts bran, 4 parts corn meal, 3 parts cotton seed meal, 3 parts linseed meal, (by weight), 6 pounds; ensilage or roots as much as were readily eaten. Beginning with the second period, Rowena and Kittie received 10 pounds ensilage.

Grain and by-products.—Hay, 10 pounds; ensilage as much as was readily eaten; when on equal weights of corn and bran, 8 pounds; when on corn oil cake or Atlas gluten meal, 2 pounds of corn, 2 of bran, and 4 of the experimental feed; when on cotton seed bran, 1 pound of corn, 1 of bran, and 6 of cotton seed bran.

Experimental error test.—Bettie; Hay, 8 pounds; mixed feed, 6 pounds; ensilage, *ad libitum*. Jessie, Marjory, Red Top, Rhoda; Hay, 10 pounds; equal weights of corn and bran, 8 pounds; ensilage, *ad libitum*.

MILKING.

In all cases changes from one experimental ration to the other were made gradually, usually from three to five days of the preliminary period being taken in getting fully upon the new ration.

Each milking was weighed. The milk given during the first six and last six days of the experimental portion of each feeding period was sampled, four six-milking composite samples being taken as representative of the period. The milk given during the intervening six days was held to have the average composition of the milk given before and after that time.

The fat was determined by the Babcock centrifugal method, and the total solids, by calculation from the specific gravity and fat per cent., using the simplified Hehner and Richmond formula.*

COWS USED IN THE EXPERIMENT.

The following table shows the cows used during the experiments. Those whose names are italicised are registered Ayrshires, the remainder are high grade Jerseys. Previous records were carefully considered, as well as age, time of calving, etc., in the selection of the cows for the various experiments, and particularly of those in the same tests. The ensilage and root tests received preference in the selections.

COWS USED IN THE EXPERIMENTS AND FODDERS FED EACH PERIOD.

	APPROXIMATE AGE, NOV. 1, 1895.	CALVED, 1895.	SERVED, 1895-96.	PERIOD NO. I	PERIOD NO. II	PERIOD NO III	PERIOD NO. IV	PERIOD NO. V
Acme	6	Oct. 4	Nov. 30	Ensilage	Beets	Ensilage	Beets	
Clover	8	Sept. 24	Jan. 17					
Effie	9	Sept. 8	Dec. 27					
Lena	-	Oct. 23	....	Beets	Ensilage	Beets	Ensilage	
Nett	7	Sept. 24	Dec. 23					
Dandelion	6	Oct. 15	....	Ensilage Carrots	Carrots Ensilage	Ensilage Carrots	Carrots Ensilage	
Lady Le Brocq.	6	Sept. 20	Dec. 30					
Jersey Lily	4	Oct. 18	....					
Rowena	4	Sept. 18	....	Beets	Carrots	Beets	Carrots	
Kittie	6	Sept. 27	Nov. 17	Carrots	Beets	Carrots	Beets	
Flora	6	Aug 12	Nov. 19	Corn and Bran	Corn Oil Cake	Corn and Bran	Corn Oil Cake	Corn and Bran
Fanny	6	Farrow	Dec. 15					
Julia	6	April 9	....					
Goldie	9	June 21	....	Corn and Bran	Corn and Bran	Corn Oil Cake	Corn and Bran	Corn Oil Cake
Idarella	5	Oct. 28	....					
Portelette	7	Dec. 6	....					
Nancy B.	8	July 18	Nov. 27	Corn and Bran	Atlas Gluten Meal	Corn and Bran	Atlas Gluten Meal	Corn and Bran
Jessaline	5	April 8	Nov. 13					
Eulalie	6	Dec. 2	....					
Brownie	6	Nov. 11	....	Corn and Bran	Corn and Bran	Atlas Gluten Meal	Corn and Bran	Altas Gluten Meal
Dora	6	Aug 17	Dec. 18					
Maizie	9	July 29	Feb. 9					
Atalanta	6	Sept. 25	Nov. 27	Corn and Bran	Cotton Seed Bran	Corn and Bran	Cotton Seed Bran	Corn and Bran
Fairie	6	Mar. 26	....					
Jeannie	6	Nov. 1	....	Corn and Bran	Corn and Bran	Cotton Seed Bran	Corn and Bran	Cotton Seed Bran
Kinkora	6	Nov. 18	....					
Bettie	7	July 19	....	Fed the same throughout the winter in order to determine the extent of experimental error.				
Jessie	6	Nov. 28	Jan. 18					
Marjory	6	Farrow	......					
Red Top	6	Oct. 28	Jan. 4					
Rhoda	6	July 30	Oct. 23					

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*$1.2 F + (L \div 4) = T$.

WEIGHTS OF COWS.

All the animals under experiment were weighed the first three days of the opening period and on the last three days of all periods. The average weights were as follows:

PERIOD.		Acme.	Clover.	Effie.	Lena.	Nett.	Dandelion.	Lady Le Brocq.	Jersey Lily	Rowena.	Kittie.	Flora.	Fanny.	Julia.
I	Beginning...	878	990	841	654	1020	793	795	827	822	837	933	940	818
I	End..........	948	1000	818	650	992	797	802	852	821	847	943	972	848
II	"	930	1010	800	652	1033	752	783	878	820	868	968	997	843
III	"	928	1008	835	...	1032	807	770	870	857	890	977	1013	835
IV	"	936	982	840	. .	1030	763	778	878	838	900	998	1025	860
V	"										N	ot	tak	en.

		Goldie.	Idarella.	Portelette.	Nancy B.	Jessaline.	Eulalie.	Brownie.	Dora.	Maizie	Atalanta	Fairie.	Jeanie.	Kinkora.
I	Beginning...	950	870	...	1000	988	...	845	765	910	850	778	855	785
I	End..........	970	845	863	1023	1038	1048	860	797	917	878	763	823	785
II	"	973	868	865	1047	1097	1078	880	813	942	888	797	850	797
III	"	968	868	862	1050	1113	1028	887	843	960	863	792	823	810
IV	"	1010	893	887	1077	1150	1078	860	865	978	872	807	793	820
V	"	Not	tak	en	thr	o u	gh	err	or.					

The animals receiving roots alternating with ensilage tended, on the whole, to lose flesh somewhat on the root rations. Thus in passing from ensilage to roots twelve times, there was a loss in weight averaging 25 pounds in seven cases, in three cases, a gain, averaging 9 pounds, and twice there was no change; while passing from roots to ensilage ten times, there was a gain in weight averaging 33 pounds in five cases, once a loss of 13 pounds, and four times, no change. This effect was expected, being due to the laxative effect of the roots, which were purposely fed in larger quantities than in ordinary practice in order to magnify, if possible, their effects upon production. Nett and Dandelion, more particularly, grew somewhat thin upon roots. Of the two cows fed upon roots throughout the winter, Rowena held her weight, and Kittie steadily gained in flesh. Jersey Lily and Acme gained largely during the first period, but increased no further. The other root-fed cows came out of the test about as heavy as they were at its beginning.

All of the sixteen cows in the grain and by-product feeding tests, except Jeannie, gained in weight. In most cases the gain continued steadily throughout the feeding periods. Jeannie shrank in weight sixty pounds.

BARN TEMPERATURE.

The temperature of the barn was taken at 5 A. M., 12 M. and 6 P. M., throughout the twenty weeks. The location of the station farm on the top of the hill, while fine from a scenic standpoint, exposes the buildings to the full sweep of the winter winds. Although there was a large number of animals housed in the barn, its average temperature was less than could have been wished, as is shown by the following summary:

PERIOD.		AVERAGE TEMPERATURE.	RANGE OF TEMPERATURE.	PER CENT. OF WHOLE WITHIN 3 ° F. OF MEAN.
I	Preliminary	44 ° F	41 to 52 °F	80
	Experimental	51 "	42 " 59 "	60
II	Preliminary	45 "	40 " 51 "	50
	Experimental	47 "	41 " 53 "	80
III	Preliminary	47 "	41 " 55 "	30
	Experimental	47 "	41 " 57 "	60
IV	Preliminary	48 "	43 " 59 "	50
	Experimental	47 "	43 " 54 "	75
V	Preliminary	49 "	43 " 57 "	30
	Experimental	58 "	48 " 69 "	10

No relation could be surely traced between the barn temperature from day to day and the quantity of milk given, even when comparatively sharp thermometric changes occurred.

The only large variations in average daily temperatures were Dec. 2 to 3, 51° to 43°; Dec. 7 to 8, 45° to 52°; Dec. 26 to 28, 57° to 50°; Feb. 1 to 2, 41° to 52°; Feb. 28 to 29, 48° to 57°; March 2, 59° to 50°; March 25 to 26, 34° to 50°; March 30 to 31, 50° to 58°; April 18 to 19, 67° to 59°.

It fortunately happened that but two of these changes involving 7° or more of thermometric variation from day to day fell within the experimental portions of the feeding periods. As has been already noted, the cows were all turned out for from twenty-five to thirty-five minutes daily, except in very cold or stormy weather, all being treated alike in this respect.

FODDERS AND FEEDS USED.

The fodders and feeds in use, except the hay, were periodically sampled and analyzed, the ensilage and roots once in two weeks, and the feeds less often. The hay was assumed to have 85.50 per cent. dry matter, the mean of all available data on the class of hay used. The average analyses of the materials used are as follows:

FODDERS.	ORIGINAL SUBSTANCE.		COMPOSITION OF DRY MATTER.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Corn Ensilage	73.34	26.66	6.19	9.53	24.78	56.54	2.96	1.52	0.458	1.500
Beets	85.62	14.38	13.81	11.09	7.14	66.94	1.02	1.77	0.521	3.388
Carrots	87.66	12.34	17.53	9.72	8.92	62.59	1.24	1.56	0.709	4.062
Corn Meal and Wheat Bran } equal parts.	12.10	87.90	4.09	15.45	6.61	68.46	5.39	2.47	1.382	1.179
Corn Oil Cake	8.81	91.19	3.93	24.66	8.59	46.94	15.88	3.95	1.340	0.302
Atlas Gluten Meal	7.79	92.21	2.73	38.15	12.73	32.11	14.27	6.12	0.652	0.223
Cotton Seed Bran	11.30	88.70	3.80	13.08	30.49	49.05	3.58	2.19	0.846	1.382
*Mixed Feed	9.95	90.05	5.32	27.24	7.86	52.05	7.53	4.36	1.352	1.659

*6 parts wheat bran, 4 parts corn meal, 3 parts each of cotton seed and linseed meals (by weight).

The question of the losses occurring in connection with the preservation of the fodders used did not enter into the present experiment. The ensilage was drier than any hitherto made at this station, particularly in the upper portion of the silos.

RECORDS OF THE FEEDING TESTS.

This station has never before had so large a number of cows engaged in experimental feeding tests as during the winter of 1895–96.

The experimental feeding of thirty-one cows, and the sampling and analysis of their feeds and milk, involved a vast amount of work. There were over 42,000 barn weights made and recorded, there were 80 samples of fodder and feeds, and over 600 samples of milk analyzed, and, finally, several hundred hours of work were put upon the collation and calculation of the records of the tests in preparation for publication. This latter portion of the work would have been even more onerous and time-consuming except for the use of the "Thatcher's Calculating Instrument."

There is no need of publishing the detailed records of the daily routine of these tests, which would, moreover, fill an immense volume. The printing of even the condensed data is space-consuming, and if given with the discussions would tend to deter the reader from even a cursory examination. Yet these final and condensed results are necessary as a matter of record, and as the basis of the conclusions drawn. They are consequently inserted in a body at the close of this article, and show:

I. The feeding of the various cows; amounts eaten of the various materials, etc.

II. The records of the individual cows during the experiment, including dry matter eaten; amounts of milk, total solids and fat given; amounts of the same given per 100 pounds of dry matter eaten, etc., etc.

Before taking up the discussion of the several tests separately, it may be remarked that when a cow eats a certain ration during a feeding period, another during a second period, returning to the first ration for a third period, all three being of equal lengths, and, so far as may be, all other things being equal, it is fair to assume, and, in the discussion of feeding experiments is usually assumed, that the average of the results obtained during the first and third periods on the ration then fed would be those which would have been found during the second period had the feeding continued on one ration. A comparison of this average with the results actually obtained with another ration serves to show the relative value of the different fodders and feeds. The comparison of these averages and the actual results form part of the data presented in the body of this article under the various tests.

The outcome may be well shown, also, by adding the total products for each period and of each calculated period. Thus, for example, in the case of the four cows, Acme, Clover, Effie and Nett, fed corn ensilage and beets, we have eight eighteen-day periods for each class of fodder, equivalent to two periods, each consisting of 144 days of experimental feeding, both strictly on a par as regards time of lactation.

The following data is added, to give the results of 144 days of experimental feeding with corn ensilage:

Acme, Clover and Effie; mean of actual results of Periods I and III, equivalent to calculated feeding during Period II; actual results of Period III.

Nett; mean of actual results of Periods II and IV, equivalent to calculated feeding during Period III; actual results of Period II.

The following data is added, to give the results of the same 144 days' experimental feeding with the same cows on beets:

Nett; mean of actual results of Periods I and III, equivalent to calculated feeding during Period II; actual results of Period III.

Acme, Clover and Effie; mean of actual results of Periods II and IV, equivalent to calculated feeding during Period III; actual results of Period II.

This calculation gives eight full records for Periods II and III on each ration.

I. CORN ENSILAGE VS. BEETS.

The four* cows fed in this experiment, as well as those receiving carrots, ate more roots than would be fed in ordinary good farm practice, in order to magnify the effects and results. The large ration of roots naturally had some laxative effect. The manure did not lose its consistency, but had a dull, muddy color, and seemed to contain some undigested hay. Only two animals of the ten which were fed roots passed much undigested hay.

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*Lena, started in this experiment, was killed during the third period.

Unfortunately the supply of beets gave out when the fourth period was about half through. Ensilage was substituted to complete the period. Calculations using the first three periods only give so nearly the same final results and conclusions that the fourth period is included as if roots had been fed throughout.

The first comparison of the record of the cow Acme is given in full to show more clearly just what is meant by the figures in the "difference tables" interspersed throughout the text of this article. It should be noted that only the experimental portion of the four-week period, *i.e.* 18 days, is considered.

Record of Cow "Acme."	Total Dry Matter Eaten.	Dry Matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER. IN ENTIRE RATION. Milk.	Total Solids.	Fat.	IN EXPERIMENTAL FODDER. Milk.	Total Solids.	Fat.
	lbs.	lbs.	lbs.	%	%	bs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Average of actual records for period I and III (Corn Ensilage.)........	431 9	213.7	513.0	12.84	3.97	65.87	20.38	118.9	15.3	4.7	241.7	31.1	9.6
Actual record for period II (Beets.)	520.2	299.9	589.4	13 21	4.09	77.88	24.09	113.3	15.0	4.6	196.5	26.0	8.0
Records made upon Beets ± those made on Corn Ensilage............	+88.3	+86.2	+75.6	+0.37	+0 12	+12.01	+3.71	–5.6	–0.3	–0.1	–45.2	–5.1	–1.6

The following tables give data of the beet feeding tests:

DIFFERENCES (IN EXPERIMENTAL FEEDING) BETWEEN THE AVERAGE OF THE RESULTS OF TWO PERIODS ON ONE RATION AND THOSE ACTUALLY OBTAINED WITH ANOTHER RATION IN THE INTERVENING PERIOD.

Names of Cows.		Total Dry Matter Eaten.	Dry Matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER.					
									IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
									Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs	lbs.	lbs.	lbs.	lbs.
Acme	Beets vs. Ensilage.	+88.3	+86.2	+75.6	+0.37	+0.12	+12.01	+3.71	—5.6	—0.3	—0 1	— 45.2	— 5.1	—1.6
Clover		+85.0	+83.8	+54.1	—0.21	- 0.40	+ 8.35	+2.09	—1.7	—0.5	—0.4	— 28.7	— 5.0	—2.3
Effie		+39.3	+41.8	+40.1	—0.39	—0.39	+ 4.49	+0.73	+2.7	+0.1	—0.2	— 37.6	— 6.0	—2.4
Nett		+22.6	+22.6	+34.9	+0.28	+0.06	+ 6.00	+1.65	+1.8	+0.6	0.0	— 9.9	- 0.6	—0.2
Total		+235.2	+234.4	+204.7			+30.85	+8.18	—2.8	—0.1	—0.7	—121.4	—16.7	—6.5
Average		+58.8	+58.6	+51.2	+0.14	—0.06	+ 7.71	+2.05	—0.7	0.0	—0.2	— 30.4	— 4.2	—1.6
Percentage differences		+15	+32	+13	+ 1	— 1	+14	+11	—7	—0	—4	— 14	—14	—16
Acme	Ensilage vs. Beets.	—56.8	—55.6	—38.6	- 0.16	—0.06	— 5.87	—1.85	+6.3	+0.7	+0.2	+ 37.1	+ 4.5	+1.4
Clover		—54.6	—54.7	—24.5	+0.10	+0.20	— 3.77	—0.92	+3.6	+0.7	+0 4	+ 26.5	+ 4.5	+1.9
Effie		—24.1	—23.7	—25.4	+0.25	+0.29	— 2.95	—0.43	—2.1	—0.1	+0.1	+ 18.8	+ 3.0	+1.3
Nett		+13.5	+14.8	+12.8	—0.05	—0.04	+ 1.35	+0.28	—1.0	—0.2	0.0	— 12.0	— 1.6	—0.5
Total		—122.0	—119.2	—75.7			—11.24	—2.92	+6.8	+1.1	+0.7	+ 70.4	+10.4	+4.1
Average		—30.5	—29.8	—18.9	—0.05	—0.02	— 2.81	—0.73	+1.7	+0.3	+0.2	+ 17.6	+ 2.6	+1.0
Percentage differences		— 7	—14	— 5	0	0	— 5	— 4	+2	+2	+4	+ 9	+ 9	+11

RESULTS OF 144 DAYS EXPERIMENTAL FEEDING.

Ensilage	3181	1433	3184	13.76	4.50	438	143	785.8	108.6	35.7	1770.3	244.5	80.8
Beets	3538	1787	3465	13.86	4.46	480	154	776.2	107.4	34.3	1578.5	218.4	70.2
Beets ± Ensilage	+ 357	+354	+ 281	+0.10	—0.04	+ 42	+ 11	— 9.6	—1.2	—1.4	—190.8	—27.1	—10.6
Percentage difference.	+ 12	+ 25	+ 9	+ 1	— 1	+ 10	+ 8	— 1	— 1	— 4	— 14	—11	—13

Ratio of per cent. of fat to per cent. of solids not fat: ensilage ration, 1 : 2.06; beet ration, 1 : 2.11.

The results of the tests may be stated as follows:

1. More dry matter was eaten when beets were fed than when corn ensilage was fed, although all that would be eaten was given of each, and each was of good quality. This is probably due to the well-known favorable effect of beets upon the general digestion and appetite.

2. Fifteen per cent. increase in the total dry matter eaten in the form of beets produced thirteen per cent. more milk, fourteen per cent. more total solids, and eleven per cent. more butter fat.

3. Seven per cent. decrease in the total dry matter eaten in the form of ensilage produced five per cent. less milk and total solids, and four per cent. less butter fat.

4. Twelve per cent. increase in the total dry matter eaten in the form of beets produced nine per cent. more milk, ten per cent. more total solids, and eight per cent. more butter fat.

5. There was no material change in the quality of the milk.

6. One hundred pounds of dry matter, both in the entire ration and in the experimental fodder, gave slightly larger returns when ensilage was fed than when it was replaced by beets, making one per cent. more milk and total solids, and four per cent. more butter fat. These differences are too small to lay stress upon, and apparently in these tests the dry matter of each fodder had about equal feeding values.

7. Inasmuch as the dry matter of corn ensilage is but 66 per cent. digestible, while that of beets ranges from 78 (mangel-wurtzels) to 94 per cent. (sugar beets) in digestibility,* it follows that a pound of digestible dry matter in corn ensilage gave larger returns in these tests than a pound of digestible dry matter in beets.

The incomplete digestion of the hay, observed during the beet-feeding periods, should be borne in mind in this connection as probably a not unimportant factor in the results.

Comparisons of the feeding value of corn ensilage and beets have been made at the Ohio and Pennsylvania stations. The results obtained may be briefly stated as follows:

Ohio (Bul. II. 1, pp. 89–100).—"Corn silage is slightly superior to field beets as a flesh or fat producer, and beets are slightly better than corn silage for milk production."

Ohio (Bul. III. 5, pp. 153–174).—"Beets have caused an increased consumption of dry matter. . . . . The feeding of beets has in each case been followed by an increased flow of milk." The dry matter of corn silage is but two-thirds digestible, and that of beets nearly all digestible, and yet more dry matter was eaten when beets were fed, "hence we must conclude that the beets exercised a more favorable influence upon the general digestion and appetite of the cows than the silage." "The cured silage in the silo would cost $2.30, and the beets in the cellar $2.36 a ton." "The cost of a pound of digestible dry matter in the beets [was] 1.01 cents, and in the silage 0.71 cents."

Ohio (Bul. 50, pp. 51–68).—More dry matter was eaten, and more milk and fat given on the beet ration. The quality of the milk remained unchanged. "In the general average of all experiments, 100 pounds of dry matter has produced 4 pounds, or approximately 6 per cent. more milk when the cows were feeding on silage than on beets." The beets yielded but half the dry matter at double the cost for raising, harvesting and storing, as compared with corn. "If they [beets] are to be used with profit, it must be in small quantity, and for the purpose of securing their effect as appetizers."

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*Jordan, American Digestion Experiments, Expt. Station Record, VI., pp. 7–8.

Pennsylvania (Rpt. 1890, p. 113).—"More milk [total solids and fat] was produced, but a larger quantity of digestible matter was consumed, ... when roots were fed."

Pennsylvania (Bul. 26, p. 4).—"As much digestible organic matter was produced on one acre, when grown as corn, as was obtained from 1.91 acres of mangels, or 2.05 acres of sugar beets. The cost of growing, harvesting, and storing an acre of beets was more than double the amount required for an acre of corn." "A net gain in feeding value of silage over roots of 5 per cent." was found in feeding trials. Roots made the most product, but at the expense of more food eaten, and, on the whole, of a loss in weight.

Vermont (Eighth Rpt., p. 148–150).—"As much total solids and fat, and nearly as much milk, were made three weeks later in lactation on the root [beets and some carrots] ration, but at the expense of about 8 per cent. more dry matter."

The results of the tests now under discussion appear to be in line with those hitherto made, and they may be all summarized as follows:

1. Beets cost more to grow, harvest and store, yield less per acre, and produce at best no more and no better milk than corn ensilage.

2. Beets are much liked by cows, and serve an excellent purpose when fed in small quantities, as an appetizer. They serve to promote the general health and digestion, particularly if no other succulent food is at hand.

2. CORN ENSILAGE VS. CARROTS.

Three cows were used in this experiment, two being started on ensilage and one on carrots. The following tables show results of feeding:

DIFFERENCES (IN EXPERIMENTAL FEEDING) BETWEEN THE AVERAGE OF THE RESULTS OF TWO PERIODS ON ONE RATION AND THOSE ACTUALLY OBTAINED WITH ANOTHER RATION IN THE INTERVENING PERIOD.

Names of Cows.		Total Dry Matter Eaten.	Dry Matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER.					
									IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
									Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	%	%	lbs	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Dandelion.....	Carrots vs. Ensilage.	+28.0	+24.0	+35.4	0.00	—0.22	+5.20	+1.17	+ 2.6	+0.3	—0 1	—17.4	—2.7	—1.5
Lady Le Brocq		+26.1	+15.5	+36 0	—0.27	—0.31	+5.13	+1.40	+ 4 3	+0.5	0.0	— 0.9	—1.5	—1.0
Jersey Lily....		— 8.0	—10.6	+14.5	—0.14	—0 28	+1.76	—0.06	+ 5.9	+0.7	+0.1	+27.1	+3.8	+ 0.9
Total........		+46.3	+28 9	+85.9			+12 09	+2.51	+12.8	+1 5	0.0	+ 8.8	—0.4	—1.6
Average.....		+15.4	+ 9.6	+28.6	—0.13	—0.27	+4.03	+0 84	+ 4.3	+0 5	0.0	+ 2.9	—0.1	—0.5
Percentage difference..		+ 4	+ 7	+10			+ 9	+5	+ 5	+4	0	+ 1	0	0
Dandelion.....	Ensilage vs. Carrots.	—26.8	—19.5	—40.2	+0.20	+0.27	—5.63	—1.43	— 4.6	—0.6	0.0	+12.9	+1.0	+0.9
Lady Le Brocq		—50.5	—28.6	—53.7	+0.26	+0 31	—8.09	—2.56	— 4.8	—0.6	—0.1	+ 2 2	+0.9	+0.8
Jersey Lily....		+ 1.4	+ 6.1	— 0.3	0.00	+0.15	—0.03	+0.45	— 0.4	—0.1	+0.0	— 9.8	—1.5	—0.3
Total........		—75.9	—42.0	—94.2			—13.75	—3.54	— 9.8	—1.3	0 0	+ 5.3	+0.4	+1 4
Average......		—25.3	—14 0	—31.4	+0 09	+0.21	—4.58	—1.18	— 3.3	—0.4	0.0	+ 1.8	+0.1	+0.5
Percentage difference...		— 7	—10	—10			— 9	—7	— 4	—3	0	+ 1	0	+4

RESULTS OF 108 DAYS EXPERIMENTAL FEEDING.

Ensilage...... ...	2030	765	1714	15.46	5.83	265	100	505.4	78.3	29.7	1366.9	212.3	80.5
Carrots...........	2152	836	1894	15.34	5.60	291	106	528.0	81 1	29.7	1370.4	211.5	77.5
Carrots ± Ensilage...........	+122	+71	+180	—0.12	—0.23	+26	+ 6	+22.6	+2.8	—0.0	+ 3.5	—0.8	—3.0
Percentage difference.........	+ 6	+ 9	+11	—1	—4	+10	+ 6	+ 4	+4	0	0	0	—4

Ratio of per cent. of fat to per cent. of solids not fat: Ensilage ration, 1 : 1.65; carrot ration, 1 : 1.74.

The results of the tests may be stated as follows:

1. Four per cent. increase in the total dry matter eaten in the form of carrots, produced 10 per cent. more milk, 9 per cent. more total solids, and 5 per cent. more butter fat.

2. Seven per cent. decrease in the total dry matter eaten in the form of ensilage, produced 10 per cent. less milk, 9 per cent. less total solids, and 7 per cent. less butter fat.

3. Six per cent. increase in the total dry matter eaten in the form of carrots, produced 11 per cent. more milk, 10 per cent. more total solids, and six per cent. more butter fat.

4. The milk made while carrots were fed was somewhat thinner than that given when ensilage was fed.

5. One hundred pounds of dry matter in the entire ration during carrot feeding produced 4 per cent. more milk and total solids, but no more butter fat than when ensilage was fed. One hundred pounds of dry matter in the experimental fodder was apparently of equal value in either ration for milk and total solids; that from carrots, however, produced 4 per cent. less butter fat. These differences are so small that no stress can safely be laid upon them, and apparently in these tests the dry matter of corn ensilage and carrots had essentially equal feeding values.

6. Since the dry matter of carrots is practically all digestible, and that of corn ensilage but two-thirds digestible, it follows that a hundred pounds of digestible dry matter in the corn ensilage gave larger returns in these tests than a hundred pounds of the same in the carrots.

Comparisons of the relative feeding values of corn ensilage and carrots have been made at the Massachusetts station. The results obtained were as follows:

"The nutritive feeding value of [the dry matter of] carrots . . . . exceeds that of the corn ensilage." (Fifth Rpt., 1887, p. 17).

"Sugar beets, as well as carrots, when fed pound for pound of dry matter in place of part of the hay ration, with the same kind and quantity of grain feed, have raised almost without exception the temporary yield of milk, exceeding, as a rule, the corn ensilage in that direction." (Seventh Rpt., 1890, p. 16).

3. BEETS VS. CARROTS.

Two cows were used in this experiment. During the first period neither received ensilage, but during the last three each received ten pounds daily in addition to the feed of roots. As already stated, the beets did not last quite through the fourth period. For these reasons the results which are expressed in the following tabulations are less trustworthy than could be wished.

DIFFERENCES (IN EXPERIMENTAL FEEDING) BETWEEN THE AVERAGE OF THE RESULTS OF TWO PERIODS ON ONE RATION AND THOSE ACTUALLY OBTAINED WITH ANOTHER RATION IN THE INTERVENING PERIOD.

Names of Cows.		Total Dry Matter Eaten.	Dry Matter Eaten in Experimental Fodder	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER. IN ENTIRE RATION. Milk.	Total Solids	Fat.	IN EXPERIMENTAL FODDER. Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Rowena	Carrots vs. Beets.	—10.3	—11.1	+26.0	—0.07	0.00	+3.22	+1.12	+ 7.2	+1.0	+0 8	+ 12.1	+ 1.7	+0 6
Kittie		—83.4	—86.4	— 0.3	+0.21	+0.20	+0.40	+0.42	+10.2	+1.7	+0.6	+ 38.6	+ 6.2	+2.4
Total		—93.7	—97.5	+25.7			+3.62	+1.54	+17.4	+2.7	+0.9	+ 50.7	+ 7.9	+ 3.0
Average		—46.9	—48.7	+12.9	0 00	+0.05	+1.81	+0.77	+ 8 7	+1.4	+0.5	+ 25.4	+ 4.0	+ 1.5
Percentage difference		—10	—21	+ 4	0	+1	+4	+5	+11	+12	+12	+16	+17	+20
Rowena	Beets vs. Carrots.	+83.2	+86.0	+ 5.3	+0.09	—0.15	+1.15	—0 43	—17 6	—2.5	—1.0	— 78.5	—11.2	— 4.0
Kittie		+180.0	+186.5	+16.1	—0.04	—0.08	+2.42	+0 68	—18.0	—2.9	—1.0	— 77.7	—12.2	— 4.4
Total		+263.2	+272 5	+21.4			+3.57	+0.25	—35.6	—5 4	—2 0	—156.2	—23 4	— 8.4
Average		+131 6	+136.3	+10.7	+0.08	—0.09	+1.78	+0.13	—17.8	—2.7	—1.0	— 78.1	—11.7	— 4.2
Percentage difference		+ 34	+ 80	+ 3	+1	—2	+4	+1	—20	—18	—21	—34	—36	—40

RESULTS OF 72 DAYS EXPERIMENTAL FEEDING.

Beets	1941	1082	1377	14.60	4.82	201	66	291.2	42 3	14 1	555.1	80.6	26.6
Carrots	1584	712	1381	14.56	4 90	201	68	344.2	50 4	17.0	761.2	111.9	38.0
Carrots ± Beets	—357	—370	+ 4	—0.04	+0.08	0	+ 2	+53.0	+8.1	+2.9	+206.1	+31.3	+11.4
Percentage difference	— 18	— 34	0	0	+ 2	0	+ 2	+18	+19	+21	+37	+39	+43

Ratio of per cent. of fat to per cent. of solids not fat: Beet ration, 1:2.03; carrot ration, 1:1.97.

The results of the tests may be stated as follows:

1. In spite of 10 per cent. less total dry matter eaten in the form of carrots, the production of milk, total solids and butter fat increased 4 per cent.

2. In spite of 34 per cent. increase in the total dry matter eaten, in the form of beets, but 3 per cent. more milk, 4 per cent. more total solids, and 1 per cent. more butter fat were produced.

3. A carrot ration with 18 per cent. less dry matter than a beet ration, and a third less dry matter in the form of roots, produced equally good returns.

4. There was no change in the quality of the milk.

5. One hundred pounds of dry matter in the carrot ration yielded about a fifth greater product than the beet ration, while one hundred pounds of dry matter in the carrots yielded about two-fifths greater product than did the same amount of dry matter in the beets.

6. The dry matter of both beets and carrots is practically all digestible; hence, in these tests the carrots far surpassed the beets in feeding value, either on the basis of dry matter or of digestible matter.

The limitations of the test stated in the opening paragraphs, and the small number of cows used, should be borne in mind; yet, if the records of the second and third periods be considered alone and apart from the others in which no hitches occurred, the results are still strongly favorable to the carrot ration. So far as the writer is aware, no tests of the comparative feeding value of these roots to cows have been made hitherto at American stations.

Among the newer by-products recently offered as stock feed are

CORN OIL CAKE, ATLAS GLUTEN MEAL, AND COTTON SEED BRAN.

Corn oil cake is a by-product of the glucose manufactories. The germs of the corn kernel are rich in oil or fat; indeed, two-thirds of the entire fat present in the kernel is located in or near the germ. These, with the husks, are separated from the remaining portions of the kernels in the process of manufacture, and, later, are subjected to extraction with naphtha and by hydraulic pressure for the purpose of obtaining the "corn oil." The residue left after extraction and pressure forms the so-called "corn oil cake." It comes upon the market in the form of cakes about one foot by two square, and about an inch thick, which are corrugated like linseed or cotton seed cake by the marks of the press. They may be readily broken or ground. The cake used in the feeding tests now under discussion, was made by the Chas. Pope Glucose Co., Geneva, Ill.

Corn oil cake is rich in both protein and fat, and has a pleasant aromatic odor. It was well relished by each of the six cows to whom it was fed. Four ate it up clean. one left a little at first, but ate it well later. One other cow was for a while off feed, and left considerable corn and bran, as well as corn oil cake.

Atlas gluten meal, strictly speaking, is misnamed. It is not in the usual acceptance of the term a gluten meal, but is a by-product obtained in the process of making alcohol from corn or grain by distillation. The starch of the grain is converted into sugar by the action of the malt which is added. Part of this sugar is then transformed, by fermentation, into alcohol, which is removed by distillation. The hull, gluten, germ, with more or less unaltered starch and some sugar, together with the malt sprouts, remain behind, and after drying compose the feed. It is made by the Atlas Distilling Co., Peoria, Ill., and was sold in this vicinity in the fall and winter of 1895 at $16 a ton, being probably the cheapest form of protein upon the market.

Atlas gluten meal is very rich in both protein and fat, has a pleasant, clean, nutty smell, and was much relished by the cows, being entirely eaten every time it was fed by each of the six cows under experiment.

Cotton seed bran (or cotton seed feed) is a by-product made by the mixture of cotton seed meal and cotton seed hulls, in various proportions, usually about one part of meal to from three to five of hulls.

Cotton seed meal is a material well known to and largely used by Vermont dairymen; they are not, however, as familiar with cotton seed hulls. The hulls of the cotton seed have long been used as fuel, and their ashes form a source of potash in fertilization, but they have only recently come into prominence as a food. They have been found, however, to be a fairly good substitute for the coarse roughages which they in some measure resemble, and cattle are readily taught to eat them. They are consequently quite serviceable in the south as a component of fattening rations, mixed with cotton seed meal as a food for making milk. Since, however, they have little, if any, more actual food value than oat straw, and since they can in no way replace any of the concentrated meals, it appears unwise to pay freight for long distances on material of such low feeding value.

Cotton seed bran was sold in this state to a limited extent during the past year at prices approximating $17.00 a ton, while cotton seed meal was selling for $23.00 a ton. The analyses of the two materials showed that roughly there were four parts of hulls present to one part of meal in the so-called cotton seed bran. The 400 pounds of meal would be worth $4.60, leaving $12.40 for 1,600 pounds of cotton seed hulls, or $15.50 a ton delivered. They sell in bulk at the mills for about $3.00 a ton, and, as already stated, have about the feeding value of oat straw. Even in case one thought best to use cotton seed bran, the meal and hulls might be bought separately, and mixed by the purchaser at a saving of from a quarter to a third of the cost of cotton seed bran during the past year in this state. It is fair to assume, therefore, unless feeding experiments show it to have a nutritive value greater than analysis would seem to indicate, that the cost of this material is out of proportion to its worth as a food for milk-making.

Cotton seed bran is low in protein and fat, and rich in the cheaper and less desirable crude fiber and nitrogen free extract. It looks like a dirty cotton seed meal, is not inviting to the eye or taste, and was not well relished by the four cows used in the test, two of them leaving more or less, and all eating it somewhat reluctantly.

The condensed data of the feeding tests with these three by-products follow. The corn oil cake and Atlas gluten meal were fed four pounds daily with four pounds of corn and bran, the cotton seed bran six pounds daily with two pounds corn and bran. Eight pounds of equal parts corn meal and bran were fed in the intervening periods.

4. CORN OIL CAKE vs. CORN MEAL AND BRAN.

DIFFERENCES (IN EXPERIMENTAL FEEDING) BETWEEN THE AVERAGE OF THE RESULTS OF TWO PERIODS ON ONE RATION AND THOSE ACTUALLY OBTAINED WITH ANOTHER RATION IN THE INTERVENING PERIOD.

Names of Cows.		Total Dry Matter Eaten.	Dry Matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER.					
									IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
									Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Flora.........	Corn Oil Cake vs. Corn and Bran.	0.00	— 1.3	+22.1	—0.34	—0.17	+2 51	+0.85	+5 8	+0 6	+0.2	+19 2	+2.2	+0.7
"		— 0 6	—10 2	+25.8	—0.02	+0 23	+3 78	+1.83	+7.7	+1.2	+0 5	+33.6	+4.9	+2.1
Fanny.........		+25.3	+ 2.4	+21.3	—0.49	—0 36	+2.19	+0.43	+2 4	+0.1	— 0.1	+13.9	+1 3	+0.1
"		— 1.0	+ 2 4	+11.3	0.00	0.00	+1 66	+0.60	+3.2	+0.4	+0.1	+ 6 3	+0,9	+0.3
Julia.........		—10.8	+ 2.4	+37.8	—0.27	—0.21	+5.35	+1.79	+11 1	+1.6	+0 5	+25.7	+3.6	+1.2
"		— 0.5	+ 2.4	+19.6	—0.20	—0.08	+2.69	+1.05	+5 5	+0.8	+0 3	+11·9	+1 6	+0.6
Goldie.........		—26 9	— 7.7	—27.1	+0.64	+0.19	—2.53	—1.05	—2.2	—0 2	0.0	— 9 0	—0.8	—0.2
Idarella		—14.4	+ 2.4	+13.4	+0.21	+0.23	+2 65	+1.44	+6 4	+1.1	+0.5	+ 5.8	+1.4	+0.9
Portelette....		+11.9	+ 2 4	—32.1	+0.23	+0.13	+5.48	+2.09	+3.9	+0 8	+0 3	+17.2	+3.2	+1.3
Total........		—17.0	— 4.8	+156.3			+23.78	+9.03	+43.8	+6.4	+2.3	+124.6	+18.3	+7.0
Average.....		+ 1.9	— 0.5	+17.4	+0.03	+0.03	+2 65	+1.00	+4.9	+0.7	+0.3	+13.8	+2.0	+0 8
Percentage difference ..		0	0	+ 7	0	+1	+ 7	+ 8	+ 8	+ 7	+7	+ 7	+ 7	+ 7
Flora.........	Corn Bran vs. Corn Oil Cake.	— 1.7	+ 5.7	—12.3	+0.22	—0 08	—1.37	- 0.80	—3.1	—0.4	—0 2	—17.2	—2.2	—1.0
Fanny		— 9 9	— 2 4	-13.8	+0.26	+0 11	—1.55	—0 52	—2.4	—0.2	—0.1	— 8 1	—0.8	—0 3
Julia		— 9.2	— 2.4	—30.7	+0 30	+0 17	—4 20	—1.50	—6.6	—0.9	—0 4	—20.5	—2 8	—1.0
Goldie		+ 5.9	+ 2.6	— 0 4	—0 02	—0.09	—0.11	—0.26	—1.3	—0.2	—0.1	— 4.7	—0.8	—0.5
Idarella.......		— 0.9	— 2.4	—40 1	—0.06	—0.18	—6.15	—2.68	—10.4	—1.6	—0.7	—26.9	—4.2	—1.9
Portelette.....		— 9.7	— 2.4	—58.9	+0.02	—0.14	—7.85	—3 29	—11.3	—1.5	—0.6	—39.2	—5.1	—2.3
Total		—25 5	— 1 3	—156.2			—21.23	- 9.05	—35.1	—4.8	—2.1	—116.6	—15.9	—7.0
Average.....		— 4.3	— 0 2	—26.0	+0.10	—0.06	—3,54	—1.51	—5.9	—0.8	—0.4	—19.4	—2.7	—1.2
Percentage difference .		— 1	0	— 9	+ 1	—1	— 8	—10	— 8	— 7	—9	— 9	— 8	—10

RESULTS OF 270 DAYS EXPERIMENTAL FEEDING.

Corn and Bran.....	**5679**	**1899**	**3830**	**14.74**	**5 25**	**564.37**	**200 96**	**995.7**	**147.6**	**52.7**	**302.5**	**446.6**	**159.2**
Corn Oil Cake.....	**5688**	**1896**	**4143**	**14.71**	**5.29**	**609 38**	**219 04**	**1074.6**	**158.8**	**57.1**	**3266.9**	**480 8**	**173 2**
Corn Oil Cake ± Corn and Bran..	**+ 9**	**— 3**	**+313**	**—0.03**	**+0.04**	**+45.01**	**+18.08**	**+78.9**	**+11.2**	**+4.4**	**+241.2**	**+34.2**	**+14.0**
Percentage difference..........	**0**	**0**	**+ 8**	**0**	**+1**	**+ 8**	**+ 9**	**+ 8**	**+ 8**	**+8**	**+ 8**	**+ 8**	**+ 9**

Ratio of per cent. of fat to per cent. of solids not fat, corn and bran ration, 1 : 1.81 ; corn oil cake ration, 1 : 1.78.

The results of these tests with six cows for twenty weeks may be stated as follows:

1. Seven per cent. more milk and milk ingredients were given when an equal weight of dry matter in the shape of corn oil cake was substituted for equal parts of corn meal and bran.

2. Nine per cent. less milk and milk ingredients were given when an equal weight of dry matter in the shape of equal parts corn meal and bran was substituted for corn oil cake.

3. Eight per cent. more milk and milk ingredients were given when an equal weight of dry matter in the shape of corn oil cake was substituted for equal parts of corn meal and bran.

4. There was no change in the quality of the milk as a result of the change in ration.

5. One hundred pounds of dry matter in the shape of corn oil cake, in the place of an equal amount of dry matter in the form of equal weights of corn meal and bran, increased the yield of milk and milk ingredients one-twelfth.

6. So far as the writer is aware, no digestion experiments have been made upon corn oil cake. The digestion co-efficients found for the dry matter of the various gluten products are sufficiently variable, and corn oil cake is so different in its character from most of the glucose by-products, that no safe estimate of the relative values of the digestible dry matter of the two grain rations can be made.

5. ATLAS GLUTEN MEAL vs. CORN MEAL AND BRAN.

DIFFERENCES (IN EXPERIMENTAL FEEDING) BETWEEN THE AVERAGE OF THE RESULTS OF TWO PERIODS ON ONE RATION AND THOSE ACTUALLY OBTAINED WITH ANOTHER RATION IN THE INTERVENING PERIOD.

Names of Cows.		Total Dry Matter Eaten.	Dry Matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF THE PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER. IN ENTIRE RATION. Milk.	Total Solids.	Fat.	IN EXPERIMENTAL FODDER. Milk.	Total Solids.	Fat.
	Atlas gluten meal vs. Corn and bran.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs	lbs.	lbs.	lbs.
Nancy B...		+5.3	+3.5	+57 0	+0.12	—0.04	+7.91	+2.05	+11.3	+1.6	+0.4	+35 8	+5.1	+1.2
" ...		+6.6	+3.1	+73.1	+0.77	+0.21	+10.40	+3.84	+16 7	+2.4	+0 9	+50.3	+7.2	+2.7
Jessaline..		+9.6	+3.1	+18 5	—0.28	—0.21	+2.06	+0 57	+3.4	+0.3	0.0	+11.6	+1.2	+0.3
" ..		+3 6	+3.1	+5.7	+0.01	—0.03	+0 81	+0.25	+1.2	+0.2	0.0	+1.6	+0.2	0.0
Eulalie.....		+46.8	+3 1	+83.3	+0.24	+0.43	+13.02	+6.16	+6.7	+1.2	+0 7	+55.4	+8 7	+4.3
"		+20.0	+3.1	+93 4	+0.43	+0.44	+15.72	+6.91	+16.6	+2.8	+1 3	+64 2	+10 9	+4 9
Brownie...		+21.6	+3.1	+76.7	+0.15	+0.20	+12 19	+5 10	+12.2	+1.9	+0.8	+51 0	+8.1	+3.5
Dora.......		—5.7	+3 1	+18.7	—0.01	+0.01	+2 93	+1.18	+6.8	+1.0	+0.3	+10.9	+1 7	+0.7
Maizie.....		—0.4	+3.1	+17.1	—0.08	+0.05	+2.23	+0.97	+4.8	+0.6	+0.3	+8 9	+1 1	+0.5
Total....		+107.4	+28.3	+443.5			+67 27	+26.98	+79.7	+12.0	+4.7	+289.7	+44 2	+18.1
Average.		+11.9	+3.1	+49.3	+0.16	+0.10	+7.47	+3.00	+8.9	+1.3	+0 5	+32 2	+4.9	+2.0
Percentage difference		+3	+2	+16	+1	+2	+18	+20	+12	+13	+15	+14	+15	+18
Nancy B...	Corn and bran vs. Atlas gluten meal.	—20.4	—3.1	—46.8	—0.18	—0.19	—6.88	—2.63	—6.7	—1.1	—0.5	—29.2	—4.4	—1.8
Jessaline...		—13.1	—3.1	—5.4	+0.07	+0.09	—0.62	—0.12	—0.2	0.0	0.0	—1.3	—0 1	+0.1
Eulalie.....		—36.5	—3.1	—98.5	- 0.23	—0.40	—14.92	—6 74	—12.5	—2.1	—1.1	—65.5	—10 3	—4.8
Brownie...		—26.9	—3.1	—23.2	—0 04	—0.27	—3.71	—2.43	+1 8	+0.2	—0.2	—10.3	—1 7	—1.5
Dora.......		+3.9	—3.1	—14 5	—0.15	—0.34	—2.54	—1.50	- 5.2	—0.9	—0.5	—7.9	—1.5	—1.0
Maizie.....		+1.6	—3.1	- 22.9	+0.08	—0.14	- 3.08	—1.44	—6.6	—0.9	—0.5	—13.9	- 2 4	—0.9
Total....		—91.4	—18.6	—208.3			—31.75	—14 86	—29.4	—4.8	—2.8	—128 1	—20.4	—9.9
Average.		+15.1	—3.1	—34.7	—0.09	—0.37	—5.29	—2.48	—4.9	—0.8	—0 5	—21.4	—3.4	—1.7
Percentage difference		—4	—2	—11	—1	—7	—11	—15	—6	—7	—11	—9	—9	—13

RESULTS OF 270 DAYS OF EXPERIMENTAL FEEDING.

Corn and bran	5,902	1,899	4,449	14.19	4.85	631.46	215 55	1107.4	157.8	54.4	3515.2	499.3	170.7
Atlas gluten meal........	6,100	1,946	5,101	14.32	5.05	730.48	257.39	1216.5	174.6	61.9	3933.0	563 9	198.7
Atlas gluten meal ± corn and bran...	+198	+47	+652	+0.13	+0.20	+99.02	+41.84	+109.1	+16.8	+7.5	+417.8	+64.6	+28
Percentage difference....	+3	+2	+15	+1	+4	+16	+19	+10	+11	+14	+12	+13	+16

Ratio of per cent. of fat to per cent. of solids not fat: Corn and bran ration, 1:1.93; Atlas gluten meal ration, 1:1 83.

The results of these tests with six cows for twenty weeks may be stated as follows:

1. Three per cent. increase in the total dry matter eaten in the form of Atlas gluten meal produced 16 per cent. more milk, 18 per cent. more total solids, and 20 per cent. more butter fat.

2. Four per cent. decrease in the total dry matter eaten in the form of corn meal and bran produced 11 per cent. less milk and total solids, and 15 per cent. less butter fat.

3. Three per cent. increase in the total dry matter eaten in the form of Atlas gluten meal produced 15 per cent. more milk, 16 per cent. more total solids, and 19 per cent. more butter fat.

4. There appeared to be a slight tendency towards richer milk when the Atlas gluten meal was fed. The ratio of fat to solids not fat was lowered as an effect of feeding this meal, it resembling the other richer glutens in this respect. (See Bul. 48, pp. 77–78). The change, however, is not large enough to have much practical significance.

5. One hundred pounds of dry matter in the form of Atlas gluten meal, in the place of an equal amount of dry matter in the form of equal parts of corn meal and bran, increased the yield of milk and total solids an eighth, and that of the butter fat a sixth.

6. The only digestion experiment thus far made* of Atlas gluten meal indicates that 80 per cent. of its dry matter is digestible, which is greater than the digestibility of equal weights of corn meal and bran. Notwithstanding this fact, assuming the correctness of this co-efficient, the digestible dry matter in Atlas gluten meal proved far more efficient as a milk and butter producer in these tests than did that of corn meal and bran.

7. As has already been noted, the selling price of this material during the winter of 1895–96 in this vicinity was but $16 per ton delivered. Late in 1896 it sold at even lower figures. It seems to be a safe form of concentrated feed. We have not had trouble in the matter of garget as with some regular gluten meals. It is unquestionably the cheapest protein now upon the market.

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*Lindsey, Twelfth Report Mass. Expt. Station, pp. 146–174.

6. COTTON SEED BRAN (OR COTTON SEED FEED) vs. CORN MEAL AND BRAN.

DIFFERENCES (IN EXPERIMENTAL FEEDING) BETWEEN THE AVERAGE OF THE RESULTS OF TWO PERIODS ON ONE RATION AND THOSE ACTUALLY OBTAINED WITH ANOTHER RATION IN THE INTERVENING PERIOD.

Names of Cows.		Total Dry Matter Eaten.	Dry matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF THE PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER.					
									IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
									Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Atalanta	Cotton Seed Bran vs. Corn and Bran.	−1.7	+1.0	−4.2	−0.25	−0.09	−1.60	−0.56	−0.8	−0 3	−0.1	−6.1	−1.6	−0.6
"		−23.8	−22.9	−37.5	0.00	−0.02	−4.61	−1 44	−3 6	−0 5	−0.1	+33.2	+4.0	+0.9
Fairie		+30.6	+1.0	+10.4	−0.36	−0.29	+0.70	−0.11	−2.8	−0.7	−0.4	+6.6	+0.3	−0.2
"		−3.6	−4.3	−16.9	+0.18	+0.03	−2.24	−0.94	−3.9	−0.5	−0 3	−7 1	−0 9	−0.4
Jeannie		+29.7	+3 6	+10.1	+0.08	−0.01	+1.73	+0.46	−4.2	−0.5	−0.3	−0.1	+0.1	0 0
Kinkora		−10.2	+1.0	−19 3	+0.23	+0.06	−2 48	−0.96	−3.8	−0 5	−0.1	−16.9	−2.1	−0.8
Total		+21.0	−20.6	−57.4			−8 50	−3.55	−19.1	−3.0	−1.3	+9.6	−0.2	−1.1
Average		+3.5	−3.4	−9.6	−0.03	−0.05	−1.42	−0.59	−3.2	−0.5	−0.2	−1 6	0	−0.2
Percentage difference		+1	−3	−3	0	−1	−3	−4	−4	−4	−6	+1	−1	−2
Atalanta	Corn and Bran vs. Cotton Seed Bran.	+6.8	+10.9	+39.5	+0.18	00.0	+5 59	+1.37	+8.2	+1.1	+0.2	+1.1	+0.7	0.0
Fairie		−8.9	+1.6	+9.9	+0.32	+0.21	+2.33	+1.09	+4.3	+0.8	+0.4	+5.4	+1.5	+0.7
Jeannie		−35.2	−6.3	−37 6	+0.50	+0.31	−3.60	−0.79	−1.3	+0.2	+0.2	−16 1	−0.9	+0.5
Kinkora		+11.5	−1.0	+8.4	+0 21	+0.01	+1.73	+0.54	+0.6	+0.2	0.0	+7.8	+1.5	+0.5
Total		−25.8	+5 2	+20 2			+6.05	+2.21	+11.8	+2.3	+0.8	−1.8	+2.8	+1.7
Average		−6.5	+1 3	+5.1	+0.27	+0.10	+1.51	+0.55	+3.0	+0.6	+0.2	−0.5	+0.7	+0 4
Percentage difference		−2	+1	+2	+2	+2	+4	+4	+3	+5	+6	0	+2	+4

RESULTS OF 180 DAYS EXPERIMENTAL FEEDING.

Corn and Bran	3852	1258	3175	13.98	4.74	443.88	150.33	816.0	114.8	39 3	2524.5	353.5	119.9
Cotton Seed Bran	3899	1232	3097	13.86	4.67	423.33	144.59	785 1	109.5	37.2	2535.9	350.5	117.1
Cotton Seed Bran ± Corn and Bran	+47	−26	−78	−0.12	−0.07	−14.55	−5 76	−30.9	−5.3	−2.1	+11.4	3.0	−2.8
Percentage difference	+1	−2	−2	−1	−1	−3	−4	−4	−5	−5	0	−1	−2

Ratio of per cent. of fat to per cent. of solids not fat. Corn and bran ration, 1 : 1.95; Cotton seed bran ration, 1 : 1.97.

The result of these tests with four cows for twenty weeks may be stated as follows:

1. One per cent. increase in the total dry matter eaten (but three per cent. decrease in that eaten in the cotton seed bran), produced 3 per cent. less milk and total solids, and 4 per cent. less butter fat.

2. Two per cent. decrease in the total dry matter eaten (but one per cent. increase in that eaten in corn meal and bran), produced 2 per cent. more milk, and 4 per cent. more total solids and butter fat.

3. One per cent. increase in the total dry matter eaten (but two per cent. decrease in that eaten in cotton seed bran), produced 2 per cent. less milk, 3 per cent. less total solids, and 4 per cent less butter fat.

4. There was no material change in the quality of the milk produced by the two rations.

5. One hundred pounds of dry matter in the form of cotton seed bran produced less milk, total solids and butter fat, than did an equal weight of dry matter as corn meal and bran. The differences, however, were not great.

6. The digestion co-efficient of the dry matter of cotton seed hulls in three trials has been found to be 41, that of the dry matter of cotton seed meal, 76. Hence, cotton seed bran may be assumed to be about half digestible. This would make the digestible dry matter of cotton seed bran much superior to that of equal weights of corn meal and bran.

7. Cotton seed bran (or feed) does not appear from these results, which are similar to those obtained elsewhere, [see next paragraph], to be worth the price asked as a milk-making food.

The Pennsylvania station (Report for 1894, pp. 44–63) found that "cotton seed feed is too expensive, in proportion to the amount of food which it contains, to successfully compete on equal terms with ordinary dairy foods at average prices."

I. EXPERIMENTAL ERROR IN FEEDING TESTS.

It is usually assumed, in the interpretation of the results of feeding trials with cows, that the variations noted in the quantity and quality of the milk and its products, following a change of ration, are due thereto, and that the relative worth of two rations may be thus measured. This assumption, however, is open to the objection that more or less of the variations observed might have occurred had no change whatever taken place in the manner and kind of feeding, because of change in weather, surroundings, health, etc., or not infrequently because of the personality of the animals. This variation in the performance of different individuals under similar circumstances constitutes what is known as the "personal equation," or the "experimental error." The disturbing effect of weather changes is usually guarded against by using two sets of cows in alternating periods, so that while one is on the experimental ration, the other is being fed the basal ration and *vice versa.* The surroundings and health are always carefully watched, and due consideration given to the effect of any changes which may occur upon the final results. The "personal equation," however, is difficult to accurately estimate. Its effect upon the final result becomes minimized in proportion as the number of animals used in the experiment is increased, and as the results obtained from the use of a certain ration are more pronounced.

During the winter of 1895–96 there were eight cows in milk at the station barn which were not being fed experimentally. Five of these cows ate unchanged rations for from twelve to twenty weeks, and were treated in every way like the cows under experiment, in matter of weights, milk and fodder sampling, etc. We have at hand, therefore, the data enabling us to study what changes, if any, took place in the quantity and quality of their milk, in spite of practically unaltered feeding. The condensed data, based on that appended to this article, and of a similar nature to that which has been given in the feeding tests, as shown in the table on page 227. The periods were of the same as those used for the experimental cows, and for the purposes of comparison alternating periods will be opposed to each other in the comparison. As Bettie's comparison is but a single one, it is placed upon both sides in order to balance. For the purposes of this comparison, the ensilage is considered the "experimental fodder."

If the showing of this table was summarized after the manner of its predecessors, it would be as follows:

1. One per cent. increase of total dry matter from the same class of fodder produced 1 per cent. more milk, 3 per cent. more total solids, and 2 per cent. more butter fat.
2. One per cent. increase of total dry matter from the same class of fodder produced 2 per cent. more milk, total solids and butter fat.
3. From the same amount of total dry matter in the same fodders, the same amount of milk, total solids, and butter fat was made.
4. The quality of the milk did not change on uniform feeding.
5. The ration remaining unchanged, one hundred pounds of total dry matter produced no more milk, total solids and butter fat, at one time than another, varying lactation stages being equalized.

The upshot of the comparison in this test with five cows, similarly fed throughout, is that their various individualities so offset each other that the result is practically zero. There being no change in ration, no change ensued in production. "In numbers there is strength," and as has been already pointed out, in proportion as the number of animals under experiment is increased, the less account may be made of "experimental error." In the 33 comparisons in the above table, 9 are zero, 14 are one per cent.,

EXPERIMENTAL ERROR.

DIFFERENCES (IN EXPERIMENTAL FEEDING) BETWEEN THE AVERAGE OF THE RESULTS OF TWO PERIODS ON ONE RATION AND THOSE ACTUALLY OBTAINED WITH ANOTHER RATION IN THE INTERVENING PERIOD.

Names of Cows.	Numbers of periods.	Total Dry Matter Eaten.	Dry matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF THE PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER.					
									IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
									Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Bettie	IV ± III and V	+9.1	+2.7	—11.5	+0 23	+0 15	—0.84	—0.07	—4.7	—0.5	—0.1	—12.2	—1.2	—0 8
Jessie	II ± I and III	+22.8	+23 7	+23.2	—0.10	—0 20	+2.97	+0.30	—0.6	—0.2	—0.2	—42.5	—6.5	—2.9
Marjory	III ± II and IV	—14.0	—14.1	—9.9	+0.25	+0.19	—0.92	—0.11	—0.1	+0.1	+0.1	+14.4	+2.6	+1.1
Red Top	II ± I and III	+ 9.9	+8.8	+30.7	+0 52	+0.20	+6.65	+2 31	+4.4	+1.1	+0 3	+8.1	+0.7	+0.5
"	IV ± III and V	+ 5.1	—1.3	—10.4	+0.28	+0.05	—0.36	—0 28	—3.4	—0.3	- 0.1	—4.1	+0.1	—0.1
Rhoda	III ± II and IV	—19 5	—20.0	—0.9	+0.24	+0 10	+0.56	+0.22	+3.5	+0.7	+0.2	+40.9	+6.9	+2.4
	Total	+13.4	—0.2	+21.2			+8.06	+2.37	—0.9	+0.9	+0.2	—0.4	+3.6	+0.7
	Average	+ 2.2	0	+3 5	+0 23	+0.06	+1.34	+0.60	—0.2	+0.2	0	—0.1	+0.6	+0.1
	Percentage differences	+1	0	+1	+2	+1	+3	+2	0	+1	+1	0	+2	+1
Bettie	IV ± III and V	+9.1	+2.7	—11.5	+0 23	+0.15	—0.84	—0.07	—4.7	—0.5	—0.1	—12.2	—1.2	—0 8
Jessie	III ± II and IV	— 3 9	—3 5	—7.6	+0.07	+0.14	—0.86	+0.15	—0.7	00	+0 1	+2.8	+0.5	+0 5
Marjory	II ± I and III	+16.6	+19.3	+25.7	+0.01	—0.11	+3.87	+1.14	+3.6	+0.5	00	—13.2	—2.2	—0.1
Red Top	III ± II and IV	—15.3	—11.1	—0.9	—0 35	—0 09	—1.70	—0.44	+3.1	+0 1	00	+16.2	+1.4	+0 5
Rhoda	II ± I and III	+ 4.0	+9.7	+21 7	+0.13	+0.03	+3 69	+1 26	+3 2	+0.7	+0.3	—8.5	—1.2	—0.5
"	IV ± III and V	+12 3	+9.8	+8.4	+0.12	—0.02	+1.62	+0.42	00	+0 1	00	—14.4	—1.9	- 0.9
	Total	+22.8	+26.9	+35.8			+5.78	+2.46	+4.5	+0.9	+0.3	29.3	—4.6	—0.8
	Average	+ 3.8	+4.5	+6.0	+0.03	+0.03	+9 6	+6.1	+0.8	+0.2	+0.1	—4.9	— 0.8	—0.1
	Percentage differences	+ 1	+3	+2	0	+ 1	+2	+2	+1	+1	+1	—2	—2	—1
	A	4962	1713	4268	14.51	5 14	619.27	219.36	1027.6	149.7	53 3	2998 4	438.2	155.9
	B	4952	1686	4253	14.61	5.15	621.55	219.27	1022.2	149.7	53.2	3027.3	446.4	157.4
	B ± A	—10	—27	—15	+0.10	+0 01	+2.28	—0.09	—5.4	0.0	—0.1	+28.9	+8 2	+1.5
	Percentage differences	0	—2	0	+1	0	0	0	—1	0	0	+1	+2	+1

Ratio of per cent. of fat to per cent. of solids not fat : A, 1 : 1.82; B, 1 : 1.84.

9 are two per cent., and but 1 is three per cent. out from truth, an average of one per cent.

Is this favorable showing made by each individual cow, or is it the result of the balance of wide plus and minus variations?

The following table shows the eleven comparisons, each expressed as

PERCENTAGE DIFFERENCES:

Names of Cows.	Numbers of periods.	Total Dry Matter Eaten.	Dry Matter Eaten in Experimental Fodder.	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	WEIGHT OF THE PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER.					
									IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
									Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Bettie	IV ± III and V	+2	+2	−3	+2	+3	−2	0	−5	−4	−2	−5	−3	−3
Jessie	II ± I and III	+5	+19	+5	−1	−4	+5	+1	−1	−1	−3	−12	−13	−16
"	III ± II and IV	−1	−2	−2	0	+3	−1	−1	−1	0	+2	+1	+1	+3
Marjory	II ± I and III	+4	+15	+10	0	−2	+10	+8	+6	+5	0	−6	−7	−1
"	III ± II and IV	−4	−12	−4	+2	+3	−2	−1	0	+1	+3	+7	+8	+9
Red Top	II ± I and III	+2	+5	+7	+4	+5	+11	+11	+4	+8	+7	+1	+5	+4
"	III ± II and IV	−3	−6	0	−3	−2	−3	−2	+3	+1	0	+6	+4	+4
"	IV ± III and V	+1	−1	−3	+2	+1	−1	−2	−4	−3	−2	−2	0	−1
Rhoda	II ± I and III	+1	+7	+8	+1	+1	+9	+8	+4	+7	+8	−4	−3	−4
"	III ± II and IV	−5	−16	0	+2	+2	+1	+1	+5	+6	+5	+18	+15	+19
"	IV ± III and V	+3	+10	+3	+1	0	+4	+3	0	+1	0	−6	−3	−6

Of the 122 comparisons other than of fodder eaten, expressed as "percentage differences," there are 13 zeros, 21 ones, 16 twos, 18 threes and 13 fours, a total of 81, or just two-thirds the entire number, with a variation of four per cent. or less. In a third of the cases, however, the variation is wider than one twenty-fifth, being in some instances excessive.

Apparently if the animals for feeding tests are carefully selected, and a sufficient number are used, the "experimental error" may be nearly disregarded. If but two or three animals are used, it will hardly be safe to dogmatically assert that fluctuations of the product are of necessity due to changes in the character of the feeding, unless they exceed four or five per cent. of the larger product.

The immediate supervision of the feeding and other details in the barn connected with these tests was in the hands of and well executed by Mr. D. D. Howe, farm superintendent. The analytical work and the bulk of the mathematical calculations were performed by Messrs. B. O. White and C. H. Jones, assistant chemists, and by Mr. Duncan Stuart, of the Junior class of the Agricultural Department of the University.

8. RECORDS OF THE TEST.

FEEDING RECORDS OF THE INDIVIDUAL COWS IN FEEDING EXPERIMENTS,

(showing pounds of each fodder and feed fed during each preliminary and experimental period).

ENSILAGE AND BEETS.

Period Number.		ACME.				CLOVER.				EFFIE.				LENA.				NETT.			
		Hay.	Mixed grain.	Ensilage.	Beets.	Hay.	Mixed grain.	Ensilage.	Beets.	Hay.	Mixed grain.	Ensilage.	Beets.	Hay.	Mixed grain.	Ensilage.	Beets.	Hay.	Mixed grain.	Ensilage.	Beets.
I	Prelim'ry	79	60	315	....	78	60	347	....	71	60	179	...	80	60	...	479	80	60	...	552
	Exp'r'nt'l	142	108	842	....	141	108	742	...	142	108	380	...	140	108	...	1154	144	108	. .	1463
II	Prelim'ry	80	60	80	764	80	60	51	727	79	60	28	472	78	60	280	35	80	60	491	43
	Exp'r'nt'l	144	108	...	1797	144	108	...	1654	138	108	...	902	140	108	463	....	142	108	931	....
III	Prelim'ry	77	60	420	60	78	60	380	64	78	60	253	20	80	60	15	531	79	60	55	729
	Exp'r'nt'l	141	108	777	....	144	108	717	....	140	108	450	...	64	48	...	341	143	108	...	1366
IV	Prelim'ry	80	60	46	780	80	60	44	703	76	60	25	447	...	D	ad.	....	80	60	389	71
	Exp'r'nt'l	141	108	548	384	144	108	542	347	143	108	346	218	...	...	...	..	144	108	789	....

ENSILAGE, BEETS AND CARROTS.

Period Number.		DANDELION.				LADY LE BROCQ.				JERSEY LILY				ROWENA.					KITTIE.				
		Hay.	Mixed grain.	Ensilage.	Carrots.	Hay.	Mixed grain.	Ensilage.	Carrots.	Hay.	Mixed grain.	Ensilage.	Carrots.	Hay.	Mixed grain.	Ensilage.	Beets.	Carrots.	Hay.	Mixed grain.	Ensilage.	Beets.	Carrots.
I	Pr'lm	76	60	225	....	79	60	255	....	80	60	...	477	80	60	...	476	....	80	60	...	....	501
	Exptl	142	108	498	...	142	108	617	....	144	108	...	1258	143	108	...	1255	....	144	108	...	....	1295
II	Pr'lm	80	60	32	554	74	60	37	610	80	60	382	57	79	60	100	....	689	80	60	100	676	....
	Exptl	143	108	...	1253	142	108	...	1248	138	108	612	....	142	108	180	....	1369	134	108	180	1814	....
III	Pr'lm	76	60	265	44	77	60	285	44	80	60	20	599	78	60	100	733	....	77	60	100	....	566
	Exptl	134	108	455	....	128	98	384	....	143	108	...	1145	139	108	180	1313	....	139	108	180	....	989
IV	Pr'lm	80	60	29	499	80	55	12	371	79	60	304	59	80	60	100	....	562	79	60	100	554	....
	Exptl	142	108	56	885	144	108	46	761	142	108	602	....	143	108	223	....	883	137	108	467	234	....

CORN OIL CAKE, AND CORN AND BRAN.

Period Number.		FLORA.				FANNY.				JULIA.				GOLDIE.			
		Hay.	½ Corn. ½ Bran.	Corn Oil Cake.	Ensilage.	Hay.	½ Corn. ½ Bran.	Corn Oil Cake.	Ensilage.	Hay.	½ Corn. ½ Bran.	Corn Oil Cake.	Ensilage.	Hay.	½ Corn. ½ Bran.	Corn Oil Cake.	Ensilage.
I	Preliminary..	100	80	....	180	96	80	...	122	100	80	....	250	101	80	....	161
	Experimental	178	144	....	396	178	144	....	289	174	144	....	561	179	144	....	435
II	Preliminary..	99	44	36	256	100	44	36	220	99	44	36	307	99	80	....	291
	Experimental	167	70	70	426	174	72	72	441	173	72	72	451	177	144	....	451
III	Preliminary..	97	78	3	188	98	77	3	197	97	78	3	229	97	31	21	169
	Experimental	174	144	....	335	177	144	....	349	174	144	....	370	177	71	62	363
IV	Preliminary..	97	44	36	187	99	44	36	196	98	44	36	193	99	76	4	223
	Experimental	175	66	64	340	176	72	72	342	177	72	72	344	179	144	....	438
V	Preliminary..	99	76	3	192	99	76	3	193	96	76	3	182	99	44	36	254
	Experimental	168	144	....	262	175	144	....	340	175	144	....	343	179	72	72	464

CORN OIL CAKE, AND CORN AND BRAN.—ATLAS GLUTEN MEAL, AND CORN AND BRAN.

Period Nnmber.		IDARELLA.				PORTELETTE.				NANCY B.				JESSALINE.			
		Hay.	½ Corn. ½ Bran.	Corn Oil Cake.	Ensilage.	Hay.	½ Corn. ½ Bran.	Corn Oil Cake.	Ensilage.	Hay.	½ Corn. ½ Bran.	Atlas Gluten Meal.	Ensilage.	Hay.	½ Corn. ½ Bran.	Atlas Gluten Meal.	Ensilage.
I	Preliminary..	100	80	....	259	....	Si	ck.		99	80	....	309	97	80	....	224
	Experimental	173	144	....	513	*134	49	....	205	177	143	...	724	179	144	....	519
II	Preliminary..	99	80	....	318	95	38	....	317	99	44	36	423	100	44	36	294
	Experimental	176	144	...	571	179	144	...	558	172	72	72	698	175	72	72	538
III	Preliminary..	99	44	37	235	100	44	37	321	99	78	3	294	98	78	3	282
	Experimental	178	72	72	422	179	72	72	601	175	144	....	540	167	144	....	454
IV	Preliminary..	99	76	4	235	99	76	4	335	100	44	36	307	98	44	36	247
	Experimental	179	144	....	425	176	144	....	596	179	72	72	535	174	72	72	412
V	Preliminary..	100	44	36	238	99	44	36	364	98	76	3	292	98	76	3	232
	Experimental	174	72	72	408	177	72	72	597	172	144	....	504	171	144	....	372

*For fourteen days only.

ATLAS GLUTEN MEAL, AND CORN AND BRAN.

Period Number.		EULALIE.				BROWNIE.				DORA.				MAIZIE.			
		Hay.	½ Corn. ½ Bran.	Atlas Gluten Meal	Ensilage.	Hay.	½ Corn. ½ Bran.	Atlas Gluten Meal.	Ensilage.	Hay.	½ Corn. ½ Bran.	Atlas Gluten Meal.	Ensilage.	Hay.	½ Corn. ½ Bran.	Atlas Gluten Meal.	Ensilage.
I	Preliminary..	100	78	....	210	100	80	....	250	90	80	....	68	100	80	....	197
	Experimental	179	144	....	538	178	144	...	600	170	144	....	167	178	144	....	419
II	Preliminary..	98	44	36	400	100	80	....	396	94	80	...	105	99	80	....	241
	Experimental	178	72	72	789	175	144	....	736	174	144	....	192	176	144	....	385
III	Preliminary..	98	78	3	391	100	44	37	367	97	44	37	113	99	44	37	216
	Experimenal	173	144	....	637	177	72	72	667	169	72	72	180	171	72	72	366
IV	Preliminary..	100	44	36	375	100	76	4	374	98	76	4	113	98	76	4	190
	Experimental	180	72	72	738	171	144	...	489	177	144	....	200	177	144	....	348
V	Preliminary..	100	76	3	422	100	44	36	320	96	44	36	107	94	44	36	176
	Experimental	171	144	....	708	170	72	72	454	169	72	72	170	169	72	72	282

COTTON SEED BRAN, AND CORN AND BRAN.

Period Number.		ATALANTA.				FAIRIE.				JEANNIE.				KINKORA.			
		Hay.	½ Corn. ½ Bran.	Cotton Seed Bran.	Ensilage.	Hay.	½ Corn. ½ Bran.	Cotton Seed Bran.	Ensilage.		½ Corn. ½ Bran.	Cotton Seed Bran.	Ensilage.	Hay.	½ Corn. ½ Bran.	Cotton Seed Bran.	Ensilage.
I	Preliminary..	99	80	....	235	95	80	....	101	99	80	....	178	100	80	....	114
	Experimental	178	144	....	623	178	144	....	239	168	144	....	358	178	144	....	360
II	Preliminary..	98	28	53	401	100	28	53	203	99	80	....	259	98	80	....	315
	Experimental	173	36	108	629	178	36	108	447	178	144	....	556	173	144	....	511
III	Preliminary..	97	74	6	310	99	74	6	214	99	24	57	314	97	24	57	223
	Experimental	177	144	....	549	178	144	....	351	177	36	108	564	176	36	108	409
IV	Preliminary..	97	31	49	305	100	31	49	195	98	70	11	314	98	69	11	266
	Experimental	174	31	86	543	179	36	102	352	155	178	....	403	177	144	....	418
V	Preliminary..	99	74	....	315	99	74	...	196	99	29	57	234	98	29	57	234
	Experimental	174	144	...	498	176	144	...	335	174	36	108	389	170	36	108	324

EXPERIMENTAL ERROR.

Period Number.		BETTIE.			JESSIE.			MARJORY.			RED TOP.			RHODA.		
		Hay.	Mixed grain.	Ensilage.	Hay.	½ Corn. ½ Bran.	Ensilage.	Hay.	½ Corn. ½ Bran.	Ensilage.	Hay.	½ Corn. ½ Bran.	Ensilage.	Hay.	½ Corn. ½ Bran.	Ensilage.
I	Preliminary.				95	80	166	99	80	233	101	80	312	100	80	292
	Experimental......				178	144	421	178	144	510	178	144	715	176	144	558
II	Preliminary.......				99	80	335	99	80	329	99	80	424	96	80	329
	Experimental......				176	144	614	173	144	580	177	144	769	168	144	568
III	Preliminary.......	77	80	402	97	80	345	99	80	250	97	80	387	98	80	242
	Experimental......	136	144	589	176	144	566	174	144	432	173	144	665	173	144	431
IV	Preliminary.......	80	80	316	100	80	317	99	80	235	98	80	370	98	80	234
	Experimental......	143	144	631	177	144	564	175	144	410	179	144	672	177	144	471
V	Preliminary.	77	80	358							97	80	349	97	80	226
	Experimental.	135	144	548							170	144	580	175	144	359

RECORDS OF THE INDIVIDUAL COWS IN FEEDING EXPERIMENTS.

ENSILAGE AND BEETS.

			PRELIMINARY PERIOD.			EXPERIMENTAL PERIOD.							WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER EATEN.					
													IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
Name of Cow.	Period Number.	Experimental Fodder.	Dry Matter Eaten. *	Dry Matter Eaten. †	Milk.	Dry Matter Eaten. *	Dry Matter Eaten. †	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Acme.	I	E	233.6	112.1	275.2	454.6	236.0	533.4	12.69	3.95	67.70	21 07	117 3	14 9	4.6	226 0	28.7	8.9
	II	B	274.1	151.7	305.0	520.2	299.9	589.4	13.21	4.09	77.88	24.09	113.3	15.0	4.6	196.5	26.0	8.0
	III	E	233.7	114.1	280.2	409.2	191.4	492.6	13.00	4.00	64.04	19 69	120.4	15.7	4 8	257.3	33.5	10.3
	IV	B	265.1	142.7	293.7	411.8	194.0	472.9	13.10	4.01	61.94	18.98	114.8	15 0	4.6	243 8	31.9	9.8
Clover.	I	E	244.2	123.5	158.0	425.7	208.0	300.4	16.72	6.54	50.21	19.64	70.5	11 8	4.6	144.4	24.1	9.4
	II	B	260 5	138.2	184.3	496.3	276.1	353.3	16.48	6.06	58.29	21.41	71.2	11.7	4.3	128 0	21.1	7.8
	III	E	225.3	104.7	173.1	396.9	176.6	298.5	16 64	6.37	49.66	19.00	75 2	12.5	4.8	169.0	28.1	10.8
	IV	B	251.6	129.2	177.7	406.7	186.4	292.6	16.60	6.30	48.56	18.42	72 0	11 9	4.5	157.0	26.0	9.9
Effie.	I	E	178.4	63.7	138.0	325.1	106.5	257.9	13.71	4.39	35.36	11.32	79 3	10.9	3.5	242.2	33.2	10.6
	II	B	209.9	88.4	162.8	365.7	150.5	290.4	13.55	4.17	39.34	12.12	79.4	10.8	3 3	193 0	26.1	8.1
	III	E	186.8	66 1	145.2	327.7	110.8	242.6	14.16	4.72	34.34	11.45	74.0	10.5	3.5	219.0	31.0	10.3
	IV	B	200.5	81.5	147.1	337.9	118.4	245.6	14.35	4.74	35.24	11 63	72.7	10.4	3.4	207.4	29.8	9.8
Lena.	I	B	199.6	77.2	170.4	375.3	158.5	335.8	15.72	5.78	52.78	19 42	89.5	14.1	5.2	211.9	33.3	12.3
	II	E	196.1	75.4	176.5	331.7	114.8	307.8	15 92	5.95	49.00	18.32	92 8	14.8	5.5	268.1	42.7	16.0
	III	B	211.6	89 2	172 2	155.6	57.7	134.5	16.01	5.94	21.54	7.99	86.4	13.8	5.1	233.1	37.3	13.8
	IV				Kill	ed.	Feb	ruar	y 14.									
Nett.	I	B	211.3	88.9	269.4	421 2	200.9	549.8	12.58	3.86	69 17	21 23	130 5	16.4	5.0	273.7	34.4	10 5
	II	E	251 5	129.1	310.2	449.5	230.9	566.1	12.80	3.85	72.44	21 82	126 0	16.1	4.9	245.3	31.4	9.5
	III	B	252 6	131 1	305.4	450.8	231.3	556.7	13.12	3.93	73.01	21.85	123 5	16 2	4.8	240.8	31.6	9.5
	IV	E	229.0	106.6	282.2	406.8	186.5	477.4	12.89	3.86	61.56	18.50	117.4	15.1	4.6	256.0	33.0	9.9

ENSILAGE, BEETS AND CARROTS.

Dandelion.	I	E	199.1	80.1	179.9	358.2	139.6	337.8	14.41	5.39	48.68	18.19	94.3	13.6	5.1	242.0	34.9	13.0
	II	C	198 6	76.1	194 0	369.4	149.9	349.4	14.73	5.31	51.46	18.54	94.6	13.9	5.0	233.1	34.3	12.4
	III	E	190.0	71.0	171.0	323.9	112.1	290.2	15.11	5.71	43.83	16.55	89.6	13.5	5.1	258 9	39.1	14.8
	IV	C	187.1	64.7	171.6	332.0	113.3	311.4	15.24	5.59	47.45	17.41	93.8	14.3	5.2	274.9	41.9	15.4
Lady Le Brocq.	I	E	212.2	90.7	143.2	391.5	172.9	279.6	16.44	6.40	45.95	17.88	71.4	11.7	4.6	161.7	26.6	10.3
	II	C	201.7	84.3	159 3	367.9	149.3	286.1	16.12	6.06	46.12	17 34	77.8	12.5	4.7	191.6	30.9	11.6
	III	E	195.7	75.9	122.9	292.2	94.6	220.6	16.33	6.34	36.02	13.99	75.5	12.3	4.8	233.2	38 1	14.8
	IV	C	163.7	45.8	117.0	317.4	97.1	262.5	16.04	6.04	42.10	15.85	82.7	13.3	5.0	270.4	43.4	16.3
Jersey Lily.	I	C	197.0	74.6	171.1	375.4	155.1	341.3	15.26	5.49	52.10	18.73	90.9	13.9	5.0	220.0	33.6	12.1
	II	E	224.2	101.8	187.0	367.1	151 9	331 3	15.29	5.65	50.67	18.70	90.3	13.8	5.1	218.1	33.4	12.3
	III	C	196.9	74.5	178.7	356.0	136.5	321.9	15.32	5.52	49.30	17.76	90.4	13 8	5.0	235.8	36.1	13.0
	IV	E	202.2	80.7	163.0	360.9	142 3	283.5	15 66	5.98	44.41	16.94	78.6	12.3	4.7	199.2	31.2	11.9

*In entire ration. †In experimental fodder.

Name of Cow.	Period Number.	Experimental Fodder.	PRELIMINARY PERIOD.			EXPERIMENTAL PERIOD							WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER EATEN.					
													IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
			Dry Matter Eaten. *	Dry Matter Eaten. †	Milk.	Dry Matter Eaten. *	Dry Matter Eaten. †	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Rowena.	I	B	199.1	76.7	237.8	391.8	172 3	467.4	13.89	4.22	62 59	19.72	119.3	16.0	5.0	271.3	36.3	11.4
	II	C	231 2	109 7	265 7	427.0	208.4	481.5	13.71	4.35	66.01	20.94	112.8	15.5	4.9	231.0	31.7	10.1
	III	B	263.7	143.0	247.8	482.8	266.6	443.6	14.20	4 49	62.98	19.92	91.9	13.0	4.1	166.4	23.6	7.5
	IV	C	211.5	89 2	219.6	372.2	152.7	395.1	14.59	5.00	57.65	19.76	106.2	15.5	5 3	258.8	37.8	12.9
Kittie.	I	C	200.7	78.3	150.5	380 0	159.7	277.3	15.24	5.22	42.27	14.47	73.0	11.1	3.8	173.7	26.5	9.1
	II	B	263 9	141.6	149.6	559.1	347.5	262.5	15.59	5 45	40 92	14.30	47.0	7.3	2.6	75.6	11.8	4.1
	III	C	210.4	90.6	121.2	378.2	162 2	215 4	16.13	5.92	34.73	12.76	56.9	9.2	3.4	132.8	21.4	7.9
	IV	B	239.2	117.7	121.9	364.0	149.7	168.8	16.44	6.15	27.74	10.38	46.4	7.6	2.9	112.8	18.5	6.9

CORN OIL CAKE, AND CORN AND BRAN.

Flora.	I	X	219.9	70.3	92.6	389.8	126.6	190.4	14.51	5.37	27.63	10.22	48.8	7.1	2.6	150.4	21.8	8.1
	II	O	219.5	71.5	120.4	373.8	125.3	211.6	14.28	5.19	30.22	10.99	56 6	8.1	2.9	168.9	24.1	8.8
	III	X	200.9	71.3	114.1	357.8	126.6	188 6	14.73	5.33	27.78	10 06	52.7	7.8	2.8	149.0	21.9	8.0
	IV	O	199 9	71.5	105.1	345.2	116.4	190.2	14.76	5.64	28.08	10.72	55.1	8.2	3 1	163.4	24.1	9.2
	V	X	200.7	69.5	101.2	333.8	126.6	140.1	14.85	5.50	20.81	7.71	42.0	6.2	2.3	110.7	16.4	6.1
Fanny.	I	X	196.6	70.3	73.8	359.8	126.6	165.8	14.65	5.33	24.29	8.84	46.1	6.8	2.5	131.0	19.2	7.0
	II	O	211.5	71.5	97.6	387.2	129 0	190.2	14.19	4.92	26.99	9.35	49.1	7.0	2 4	147.4	20 9	7.2
	III	X	203.2	70.4	96.8	363.9	126.6	172.0	14.71	5.23	25.31	9.00	47.3	7.0	2.5	135.9	20.0	7.1
	IV	O	203.7	71.5	96.4	360.3	129.0	181.3	14.75	5.35	26.73	9.69	50.3	7.4	2.7	140 6	20.7	7.5
	V	X	201.0	69.5	98.7	358.7	126.6	168.0	14.78	5.46	24.83	9.17	46.8	6.9	2.6	132.7	19.6	7.2
Julia.	I	X	244.8	70.3	130.8	432.6	126.6	248.3	16.04	6 24	39.82	15 50	57.4	9.2	3 6	196.2	31.5	12.2
	II	O	232.2	71.5	148.9	388.8	129.0	276 1	15.87	6.06	43.81	16.74	71.0	11.3	4.3	214.0	34.0	13.0
	III	X	211.1	71.3	140.3	366.5	126.6	228.3	16.25	6.31	37.09	14.40	62.3	10.1	3.9	180.3	29.3	11.4
	IV	O	202 2	71.5	126.1	362 6	129.0	241.9	16.03	6.22	38.77	15.06	66.7	10.7	4.2	187.5	30.1	11.7
	V	X	195 8	69.5	122.2	359.7	126.6	216.3	16.21	6.30	35.06	13.62	60.1	9.7	3.8	170.9	27.7	10.8
Goldie.	I	X	213.9	70.3	118.8	401.5	126.6	258.5	15.67	5.85	40.51	15.12	64.4	10.1	3.8	204.2	32.0	11.9
	II	X	227.0	70.3	152.6	389.8	126 6	296.2	15.44	5.63	45.73	16.67	76.0	11.7	4.3	234.0	36.1	13.2
	III	O	171.3	46.5	137.6	359 6	118.9	242.9	15.75	5.83	38.25	14.17	67.6	10 6	3.9	204.3	32.2	11.9
	IV	X	209 3	70.5	143.9	383.1	126 6	243.7	15.52	5.65	37.83	13.76	63 6	9.9	3.6	192.5	29.9	10.9
	V	O	217.8	71.5	138.9	394.7	129.0	245.2	15.34	5.66	37.62	13.87	62.1	9.5	3.5	190.1	29.2	10.8
Idarella.	I	X	248.0	70.3	145.0	418.3	126 6	285.1	14.65	5.22	41.77	14.88	68.2	10 0	3 6	225 2	33.0	11.8
	II	X	233.7	70.3	169.4	418.8	126.6	331.1	14 88	5.17	49.26	17.13	79.1	11.8	4.1	261.6	38.9	13.5
	III	O	214.4	72.4	182.4	385.1	129.0	321.1	15.07	5.43	48.38	17.43	83.4	12 6	4.5	248.9	37.5	13.5
	IV	X	212.3	70.5	163 4	380.1	126.6	284.2	14.85	5.22	42.20	14.84	74.8	11.1	3.9	224.5	33.3	11.7
	V	O	214.8	71.5	170.4	376.8	129.0	327.5	14.75	5.38	48.31	17.61	86.9	12.8	4.7	253.9	37.4	13.7
Portelette.	I	X	.....	.....	.....	215.1	43.1	. ...	....	.....	9 49	2.85	.....	4.4	1.3	.....	22.0	6.6
	II	X	193.1	33.4	300.7	418.1	126.6	573.9	12.93	4.09	74.21	23.46	137.3	17.8	5.6	453.4	58 6	18.5
	III	O	237.2	72.4	300.5	430.0	129.0	550.8	13.43	4.32	73.96	23.81	128.1	17.2	5.5	427.0	57.3	18.5
	IV	X	236.6	70 5	286.7	418.0	126.6	463.4	13 54	4.31	62.75	19.97	110.9	15.0	4.8	366.1	49.6	15.8
	V	O	244.5	71.5	265.9	425.3	129.0	494.7	13.59	4.59	67.24	22 69	116.3	15.8	5.3	383.5	52.1	17.6

*In entire ration. †In experimental fodder.

ATLAS GLUTEN MEAL, AND CORN AND BRAN.

Name of Cow.	Period Number.	Experimental Fodder.	PRELIMINARY PERIOD.			EXPERIMENTAL PERIOD.							WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER EATEN.					
													IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
			Dry Matter Eaten.*	Dry Matter Eaten.†	Milk.	Dry Matter Eaten.*	Dry Matter Eaten.†	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Nancy B.	I	X	264.8	70.3	214.3	480.1	125.8	389.8	12.81	3.95	49.92	15.41	81.2	10.4	3.2	309.9	39.7	12.3
	II	A	261.3	71.9	231.1	450.0	129.7	436.3	13.08	3.89	57.05	16.96	97.0	12.7	3.8	336.4	44.0	13.1
	III	X	229.1	71.4	220.6	409.2	126.6	368.8	13.11	3.91	48.35	14.41	90.1	11.8	3.5	291.3	38.2	11.4
	IV	A	232.1	71.9	212.6	409.2	129.7	394.9	13.53	4.34	53.41	17.12	96.5	13.1	4.2	304.5	41.2	13.2
	V	X	224.3	69.6	196.7	396.1	126.6	274.8	13.71	4.42	37.67	12.15	69.4	9.5	3.1	217.1	29.8	9.6
Jessaline	I	X	232.9	70.3	70.3	425.1	126.6	132.7	13.51	4.82	17.92	6.39	31.2	4.2	1.5	104.8	14.2	5.0
	I	A	230.3	71.9	80.1	412.8	129.7	161.7	13.32	4.70	21.54	7.60	39.2	5.2	1.8	124.7	16.6	5.9
	III	X	225.3	71.4	86.7	381.2	126.6	153.7	13.68	4.98	21.03	7.66	40.3	5.5	2.0	121.4	16.6	6.1
	IV	A	215.8	71.9	85.7	375.8	129.7	156.5	13.90	5.08	21.75	7.95	41.7	5.8	2.1	120.7	16.8	6.1
	V	X	209.7	69.6	90.1	363.1	126.6	147.9	14.09	5.23	20.84	7.73	40.7	5.7	2.1	116.8	16.5	6.1
Eulalie.	I	X	228.8	68.6	201.9	430.4	126.6	504.0	13.73	4.40	69.18	22.17	117.1	16.1	5.2	398.1	54.6	17.5
	II	A	254.8	71.9	280.3	477.7	129.7	554.0	14.24	5.01	78.91	27.74	116.0	16.5	5.8	427.2	60.8	21.4
	III	X	252.4	71.4	277.6	431.4	126.6	437.3	14.32	4.80	62.60	20.98	101.4	14.5	4.9	345.4	49.5	16.6
	IV	A	248.6	71.9	260.9	458.1	129.7	511.6	14.88	5.41	76.13	27.79	111.7	16.6	6.1	394.5	58.7	21.4
	V	X	257.6	69.6	256.2	444.7	126.6	399.1	14.59	5.16	58.21	20.60	89.8	13.1	4.6	315.2	46.0	16.3
Brownie.	I	X	244.8	70.3	244.5	447.0	126.6	440.9	14.04	4.95	61.92	21.83	98.6	13.9	4.9	348.3	48.9	17.2
	II	X	253.9	70.3	248.2	458.9	126.6	452.9	14.58	5.25	66.05	23.79	98.7	14.4	5.2	357.8	52.2	18.8
	III	A	249.5	72.8	270.1	445.3	129.7	504.7	15.07	5.57	76.04	28.10	113.4	17.1	6.3	389.1	58.6	21.7
	IV	X	247.0	70.5	250.6	388.4	126.6	403.0	15.30	5.51	61.65	22.20	103.7	15.9	5.7	318.3	48.7	17.5
	V	A	235.1	71.9	244.0	385.2	129.7	347.6	15.74	6.09	54.67	21.15	90.3	14.2	5.5	268.0	42.1	16.3
Dora.	I	X	171.4	70.3	96.9	318.7	126.6	188.5	15.72	6.13	29.63	11.56	59.1	9.3	3.6	148.9	23.4	9.1
	II	X	176.7	70.3	105.8	323.1	126.6	187.6	15.68	6.01	29.42	11.28	58.1	9.1	3.5	148.2	23.2	8.9
	III	A	183.8	72.8	108.4	318.5	129.7	198.0	15.66	6.01	31.02	11.89	62.2	9.7	3.7	152.6	23.9	9.2
	V	X	181.8	70.5	104.1	325.2	126.6	171.0	15.65	5.99	26.76	10.24	52.6	8.2	3.2	135.1	21.1	8.1
	IV	A	180.0	71.9	101.8	324.0	129.7	173.0	15.94	6.70	27.57	11.59	53.4	8.5	3.6	133.4	21.3	8.9
Maizie.	I	X	225.9	70.3	146.4	396.2	126.6	266.0	14.44	5.04	38.42	13.40	67.2	9.7	3.4	210.1	30.4	10.6
	II	X	215.6	70.3	148.3	372.6	126.6	246.4	14.27	5.02	35.17	12.37	66.1	9.4	3.3	194.7	27.8	9.8
	III	A	211.1	72.8	130.6	366.0	129.7	240.5	14.16	5.03	34.04	12.10	65.7	9.3	3.3	185.4	26.3	9.3
	IV	X	200.5	70.5	113.9	360.2	126.6	200.4	14.20	4.93	28.45	9.88	55.6	7.9	2.7	158.3	22.5	7.8
	V	A	195.0	71.9	117.0	351.2	129.7	206.1	14.07	5.12	29.01	10.54	58.7	8.3	3.0	158.9	22.4	8.1

COTTON SEED BRAN, AND CORN AND BRAN.

Atalanta.	I	X	238.5	70.3	240.3	451.4	126.6	455.6	12.07	3.50	55.00	15.95	100.5	12.1	3.5	359.9	43.5	12.6
	II	S	254.8	71.6	244.4	431.6	127.6	444.5	11.93	3.39	53.03	15.07	103.0	12.3	3.5	348.4	41.6	11.8
	III	X	230.2	70.3	243.1	413.1	126.6	441.8	12.28	3.46	54.26	15.30	07.0	13.1	3.7	349.0	42.9	12.1
	IV	S	227.9	70.8	216.8	380.9	103.7	360.1	12.30	3.55	44.30	12.78	94.5	11.6	3.4	347.3	42.7	12.3
	V	X	226.1	65.0	220.7	396.3	126.6	353.3	12.33	3.72	43.55	13.13	89.2	11.0	3.3	279.1	34.4	10.4

* In entire ration. † In experimental fodder.

Name of Cow.	Period Number.	Experimental Fodder.	PRELIMINARY PERIOD.			EXPERIMENTAL PERIOD.							WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER EATEN.					
													IN ENTIRE RATION.			IN EXPERIMENTAL FODDER.		
			Dry Matter Eaten.*	Dry Matter Eaten.†	Milk.	Dry Matter Eaten.*	Dry Matter Eaten.†	Milk.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Fairie.	I	X	187.4	70.3	135.6	354.2	126.6	245.4	15.55	5 94	38.16	14.58	69.3	10 8	4.1	193.9	30.1	11.5
	II	S	207.4	71.6	133.1	390.6	127 6	258.9	15.36	5.71	39.77	14.79	66.3	10.2	3.8	202.9	31.2	11.6
	III	X	208.1	70.3	141.2	365.7	126.6	251.6	15.89	6.05	39 97	15.21	68.8	10.9	4.2	198 7	31.6	12.0
	IV	S	203.7	70.8	129.6	358.5	122.3	224.5	15 81	5.99	35.50	13.44	62.6	9.9	3.7	183 6	29.0	11.0
	V	X	197.2	65.0	140.5	358.4	126.6	231.1	15.36	5.86	35.51	13.55	64.2	9.9	3.8	182 6	28.1	10.7
Jeannie.	I	X	218.2	70.3	233.0	379.0	126.6	433 9	13 68	4.76	59 33	20.63	114.5	15 7	5.4	342.7	46 9	16.3
	II	X	219.1	70.3	240.7	416.8	126.6	441 3	13.97	4.73	61 64	20.87	105.9	14.8	5.0	348 6	48.7	16.5
	III	S	234.4	71.8	221.3	417.7	127.6	394.8	14.26	4.90	56 30	19.34	94.5	13.5	4.6	309.4	44.1	15.2
	IV	X	231.5	71.3	215.3	359.1	121.3	328.0	14.48	5.15	47.50	16.89	91.3	13.2	4.7	270.4	39.2	13.9
	V	S	217.6	76.2	186.6	370.8	127.6	336.3	13.65	4.76	45.90	16.02	90.7	12.4	4.3	263.6	36.0	12.6
Kinkora.	I	X	196.4	70.3	122.9	379 7	126.6	225.9	15.14	5.54	34.20	12.28	59 5	9.0	3.2	178.5	27.0	9.7
	II	X	232.2	70 3	137.8	401.3	126 6	248.1	15.00	5.55	37 23	13 78	61.8	9.3	3.4	196 0	29.4	10.9
	III	S	210.1	71.8	117 6	378.8	127.6	207 4	15.59	5.76	32.34	11.95	54.8	8.5	3.2	162.6	25.4	9.4
	IV	X	211.7	70.5	109.6	376 7	126.6	205.3	15.79	5.86	32.41	12.03	54.5	8 6	3 2	162.2	25 6	9.5
	V	S	216.8	76.2	106.1	351.6	127.6	186 4	15.57	5.91	29.02	11.02	53.0	8.3	3.1	146.1	22.8	8.6

EXPERIMENTAL ERROR.

Bettie.	III		237.7	99.9	212.8	391.1	145.1	369 9	14.31	4.86	52.93	17.99	94 6	13.5	4.6	254.9	36.5	12.4
	IV		217.2	76.8	200.6	401.2	149.2	345.7	14.50	5.07	50.14	17.51	86.2	12 5	4.4	231.7	33.6	11.7
	V		225.9	88.1	188 6	393.1	147.9	344.5	14.23	4.98	49.02	17.17	87.6	12.5	4.4	232.9	33.1	11.6
Jessie.	I		210.6	59.1	227.8	396.8	118.0	473.6	14.39	5.03	68.14	23.82	119 3	17.2	6.0	401.3	57.7	20.2
	II		237.9	83.0	266.3	429.5	152.4	462.7	14.74	5.15	68.18	23.83	107.7	15.9	5.6	303 6	44.7	15.6
	III		238.9	85.7	238.5	416.5	139.4	405.3	15.36	5.73	62.27	23.24	97.3	15.0	5.6	290.8	44.7	16.7
	IV		233.0	77.1	210.4	411.2	133.3	363.1	15.99	6.15	58.07	22.34	88.3	14 1	5.4	272.4	43.6	16.8
Marjory.	I		237.8	82.9	128.4	421.8	143.0	263 3	14.42	5.40	37.96	14 21	62.4	9.0	3.4	184.1	26.5	9.9
	II		236.4	81.5	144.3	418.4	144.0	281.1	14.98	5.55	42.10	15.60	67.2	10.1	3.7	195.2	29.2	10.8
	III		217.0	62.1	145.4	381.8	106.4	247 5	15.56	5.94	38.50	14.70	64.8	10.1	3.9	232.6	36.2	13.8
	IV		212.1	57.2	135.5	373.1	96 9	233 7	15.72	6.00	36.74	14.01	62 6	9.9	3.8	241 2	37.9	14.5
Red Top.	I		267.7	111.0	273.9	479.2	200.4	495.3	12.78	4.11	63.32	20.35	103.3	13.2	4.3	247.2	31.6	10.2
	II		260.1	105.1	266.7	468.7	190.9	499.3	13.64	4.53	68.10	22.60	106.5	14 5	4.8	261.6	35.7	11.8
	III		249.4	96.2	259.3	438.3	163.8	441.8	13.49	4.58	59.57	20 22	100.8	13.6	4.6	269.7	36 4	12.3
	IV		244.1	90.0	238.1	438.5	158 9	390.0	13.96	4.80	54.43	18.72	88.9	12.4	4 3	245.4	34.3	11.8
	V		239.1	85.9	197.9	428 5	156.6	358.9	13.93	4.95	50.01	17.78	83.8	11.7	4.2	229.2	31.9	11.4
Rhoda.	I		259.7	103.9	156.8	433.5	156.4	285.6	14.51	5.15	41.45	14.70	65.9	9.6	3.4	182.6	26.5	9.4
	II		233.9	81.5	167.0	411.1	141.0	309.2	15.17	5.38	46.92	16.65	75.2	11.4	4.1	219.3	33.3	11.8
	III		214.2	60.1	167.3	380.7	106.2	289.4	15.55	5.56	45.01	16.08	76.0	11.8	4.2	272.5	42.4	15.1
	IV		211.0	56.9	154.2	389.2	111.3	271.4	15.46	5.55	41.97	15.07	69.7	10.8	3.9	243.9	37 7	13.5
	V		208.8	55.6	143.5	373.1	96.9	236.5	15.09	5.59	35.68	13.22	63.4	9.6	3.5	244.1	36.8	13.6

*In entire ration. †In experimental fodder.

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